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THE NEW PACIFIC CABLE FROM SAN FRANCISCO TO HONOLULU, HAWAII.

BY WILLIAM H. CRAWFORD, JR.

At 2 o'clock on the morning of December 15 the big cable ship *Silvertown* left a point about six miles off the Golden Gate, San Francisco, and started on her long voyage of cable-laying to Honolulu, Hawaii. Although these interesting operations have been attracting attention off and on since the days of the first Atlantic cable in 1858, until nearly every corner of the world is now reached by telegraphic connections, particular significance attaches itself to this venture, for it is probably the last important link to be made in the world's history of this universal intercommunication. With the advent and rapid development of wireless telegraphy it seems almost as though this operation was undertaken none too soon, if those interested wished to push their original idea through to completion in time to get some financial return for the money invested.

ATTEMPTED LANDING OF THE NEW PACIFIC CABLE, GOLDEN GATE, CAL., DECEMBER 12, 1902.

The cable ship *Silvertown*, a veteran at the business, was the boat selected by the contractors to do this work for the Pacific Commercial Cable Company. It is said that away back in 1873, when this boat was built, the officials of the India Rubber, Gutta Percha, and Telegraph Works Company, her owners, drew on a card three large circles representing as many tanks for holding coiled cable, and that they handed the card to the shipbuilders with these instructions, "Build us a ship around these tanks"; and seeing the *Silvertown*, the story is easy of belief. Viewed from a distance, she is an awkward-looking craft, something after the style of the grain carriers of the Great Lakes. She has cumbersome apparatus at the bow and stern where the "paying-out" and "picking-up" machinery is located. Everything, of course, has been sacrificed to best suit the great work for which she was intended, although it is only fair to state that within she is as snug as a private yacht, providing every possible luxury for the 32 officers and 127 men that go to make up her crew and the cable-laying force.

The *Silvertown* came out to San Francisco from London in seventy-five days and brought coiled up in her hold 2,413 nautical miles, or 4,807 tons, of submarine cable in the three big tanks. During the long voyage out, Henry Benest, engineer-in-chief of the expedition, was sending and receiving messages to himself, telegraphed from one end of the cable to the other as it rested in the ship's hold—this to quickly determine if there was any deterioration in the cable's insulation, due to heat or other causes. The three massive tanks about which the ship is built are located forward of the engine and boiler room space. The main tank is 53 feet in diameter and 31 feet 11 inches in depth, the forward tank is 46 feet in diameter, and the after tank 51 feet diameter. In the center of each tank is a hollow hub in which surplus lengths are stored, and around this hub, like thread on a spool, the cable is tightly wound.

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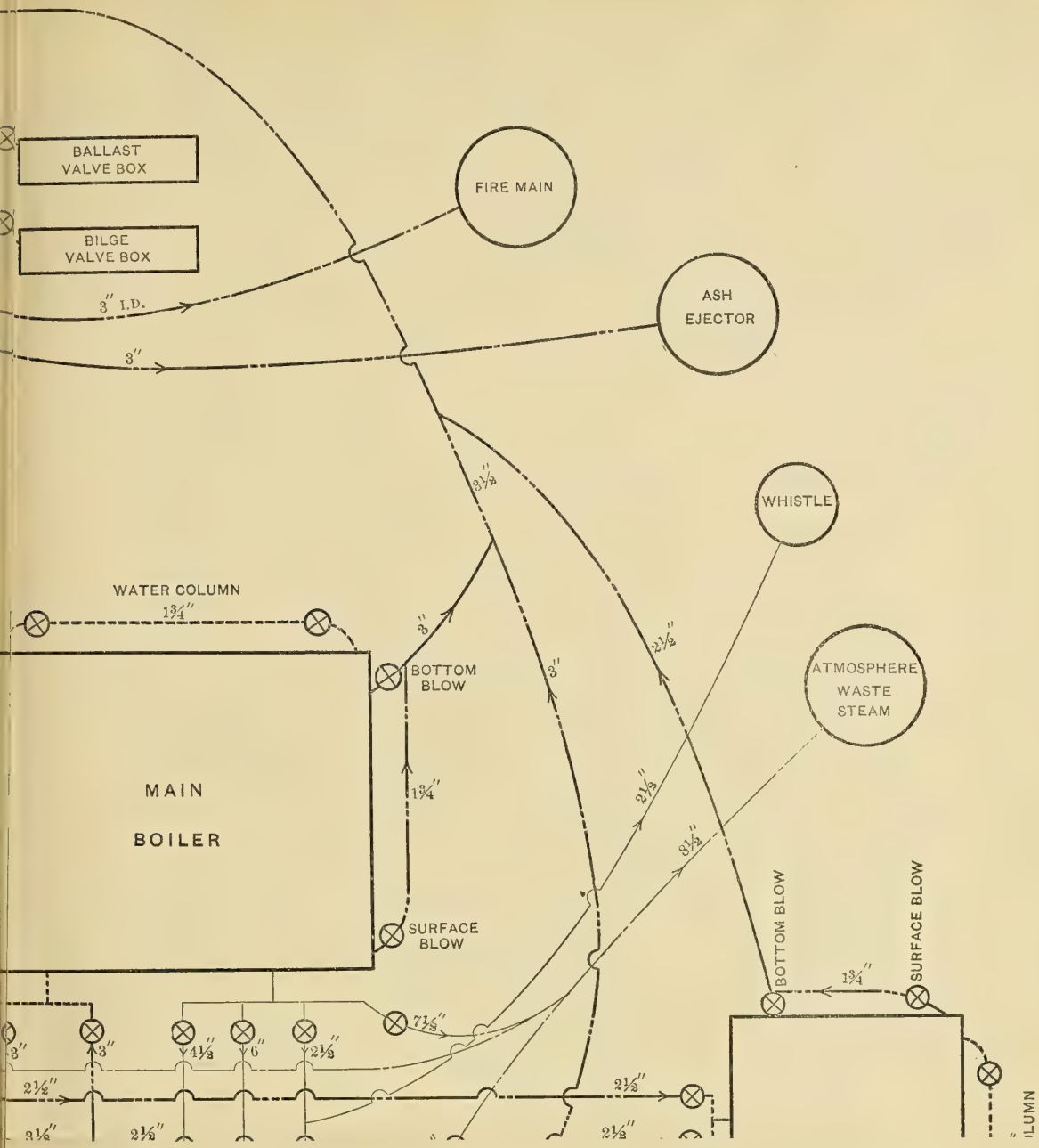
BALLAST VALVE BOX
BILGE VALVE BOX
FIRE MAIN
ASH EJECTOR
3" I.D.
3"
3½"
WHISTLE
WATER COLUMN
1¾"
3"
BOTTOM BLOW
3"
2½"
ATMOSPHERE WASTE STEAM
MAIN BOILER
1¾"
2½"
8½"
SURFACE BLOW
BOTTOM BLOW
SURFACE BLOW
1¾"
7½"
3"
3"
4½"
6"
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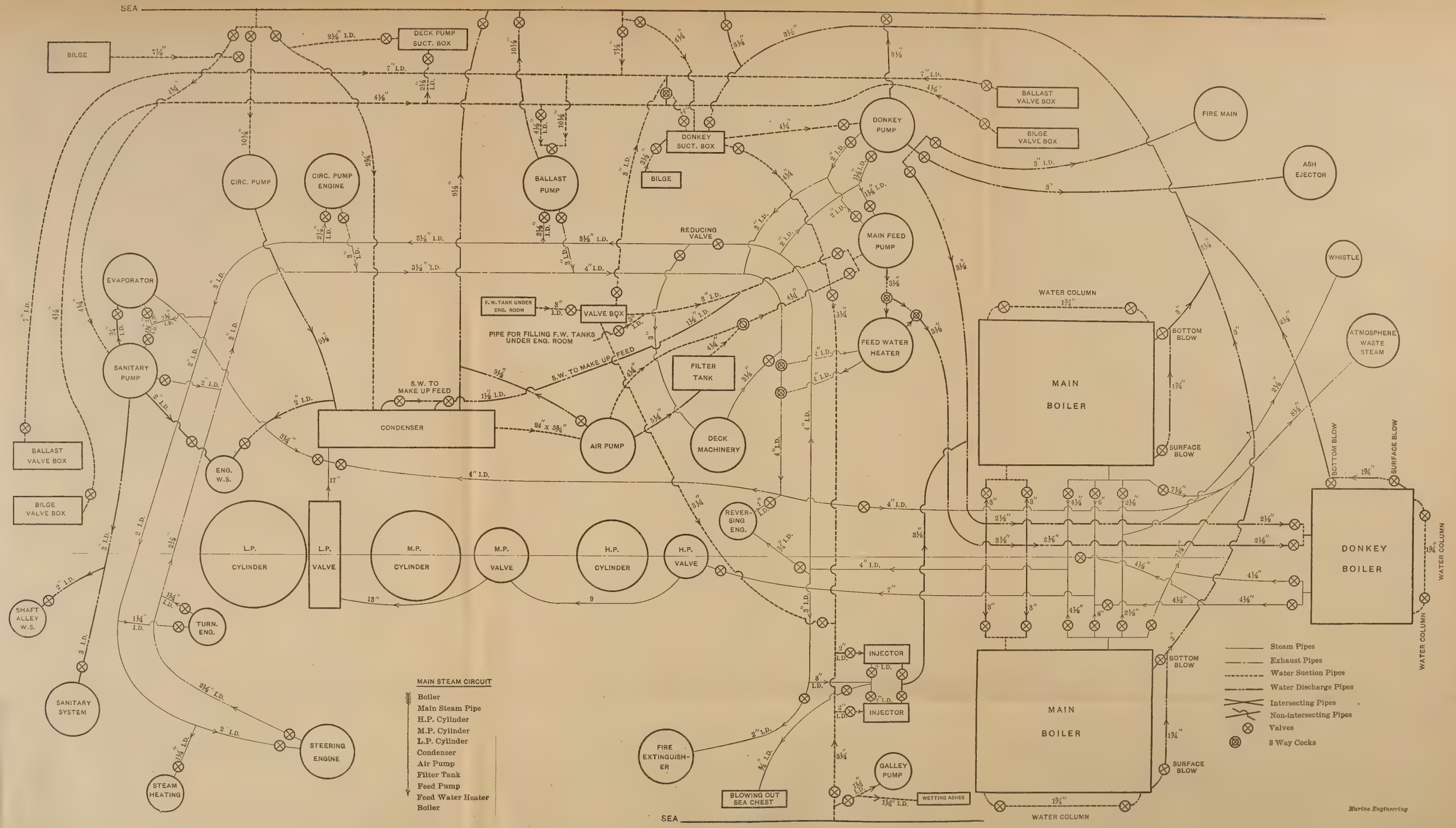


DIAGRAMMATICAL PIPE PLAN OF A TRIPLE-EXPANSION MARINE ENGINE.

FOR DESCRIPTION SEE PAGE 71.

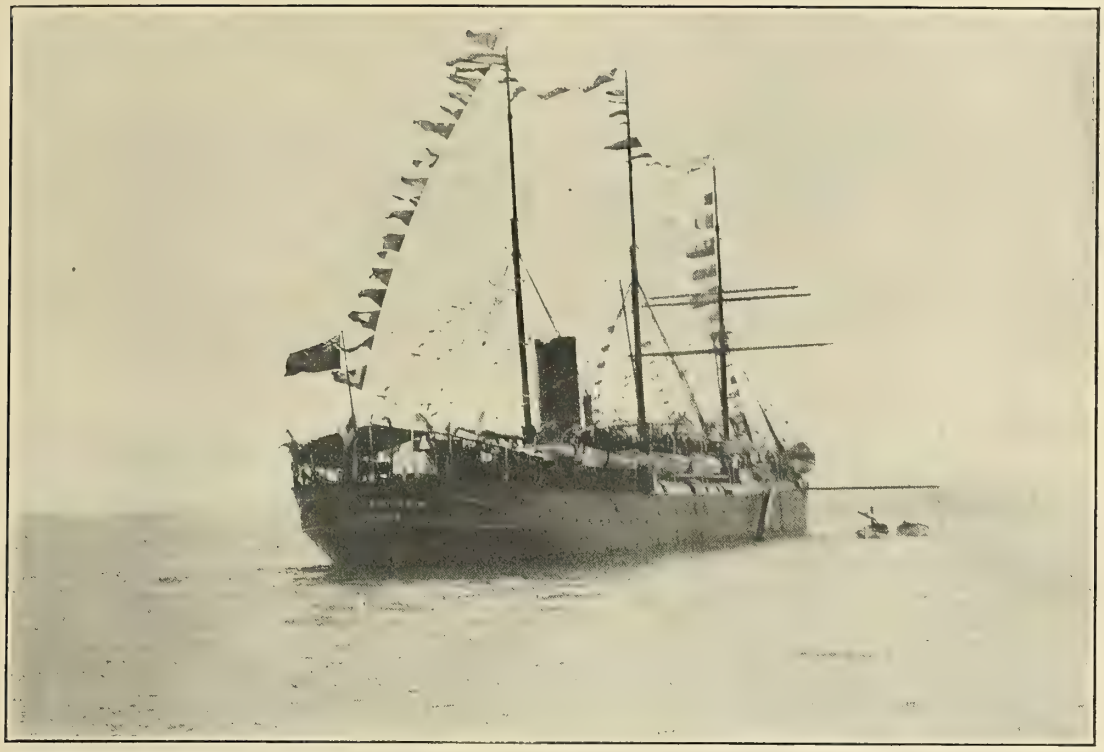
The "paying-out" gear consists of a large revolving drum located on the after deck, starboard side, and around which the cable is passed four or more times. The speed of this drum is regulated by automatic governors and it is driven by a heavy set of engines, being kept at a speed slightly in excess of the overground gait of the vessel, to allow for the irregularity of the submarine landscape. The actual overground distance from San Francisco to Honolulu is 2,099 nautical miles, while the cable is estimated to cover 2,413 nautical miles of the great valleys and mountains that make up the bed of the Pacific. Guide wheels conduct the cable after it leaves this drum under the dynamometer pulley and from there to the stern sheaves. A large scale above the dynamometer pulley indicates at all times in hundredweights the strain on the cable, and hence the automatic regulation of the paying-out speed.

If all goes well this ship makes between six and seven knots per hour while paying out cable, and the operation is continuous until the end of the journey is reached, unless bad weather is encountered, in which case the cable is cut, the end buoyed and thrown overboard, while the ship looks out for herself. When conditions are again favorable she returns to the spot, and after regaining the lost end a splice is made and the journey continued. As the cable is exhausted from one tank the loose end is secured and spliced to the end of the cable coiled in the next tank, this being done in plenty of time, so that no delay is occasioned when the transfer is made from one tank to the other.

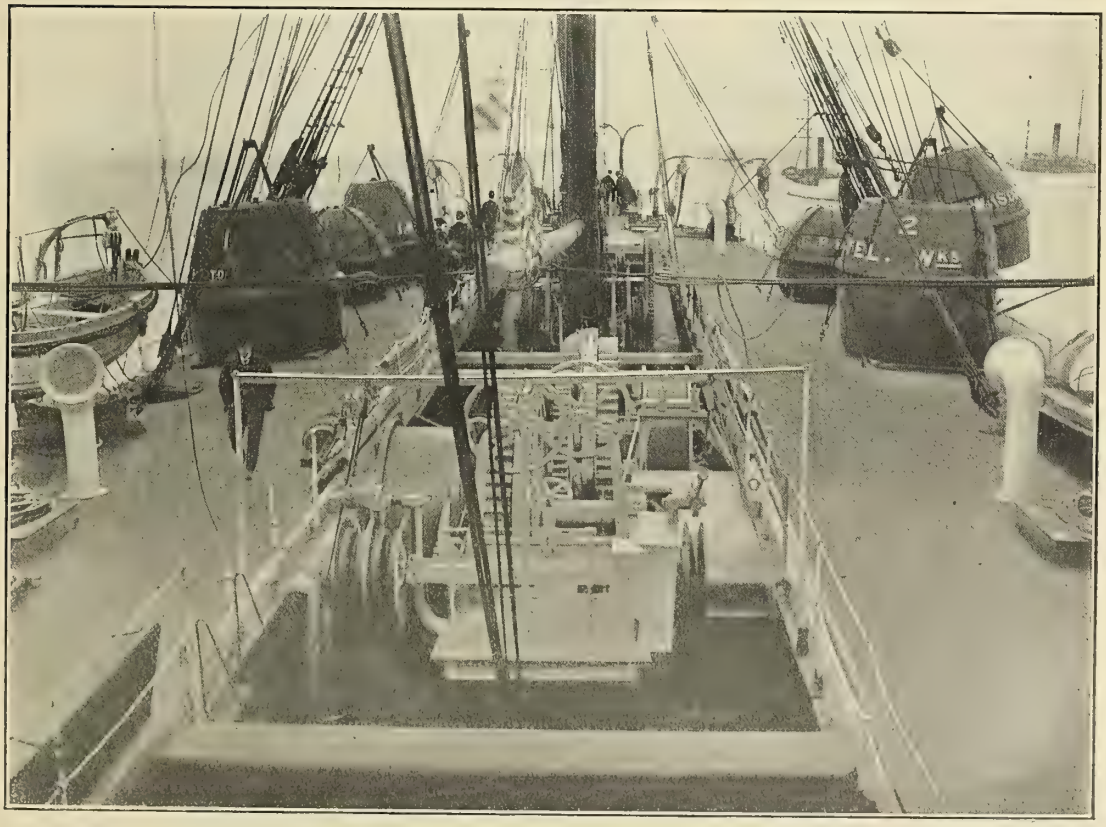
The "picking-up" or lifting gear is forward at the forecastle head and is used to recover the cable should it need repairing or be lost in rough weather.

On Friday, December 12, after lying in the harbor for a week, the *Silvertown* steamed out through the Golden Gate and came to an anchorage half a mile south and about 1 1-4 miles off shore. This was about 8 o'clock A.M., and immediately preparations were begun for getting a line ashore. The life-saving crews from Fort Point and South Side were out in their boats, in case of any trouble, and the Golden Gate crew had a position on the beach directly in line with the proposed landing place, their boat on its truck all ready for launching in case of emergency. It is estimated that between 30,000 and 40,000 people assembled to view the operation, the occasion being one of general interest. It was soon seen that the strong back tide running out through the Gate was turning the *Silvertown* around out of position, so the services of a powerful wrecking tug were engaged to pass a line to her stern and hold her in position against the tide. A heavy ground swell that had been running all morning made the big ship roll around in a threatening way and delayed until quite late the landing of a line from her. At last, however, the Golden Gate life-saving crew received a signal at their stand on the beach to launch their boat and bring the line ashore. This was accomplished with some little difficulty; however, the one-inch rope was at last made fast to the team of twelve horses that awaited it on the beach. This rope was used to bring

SUCCESSFUL LANDING OF THE PACIFIC CABLE, DECEMBER 14, 1902.



THE CABLE SHIP SILVERTOWN, USED IN LAYING THE NEW PACIFIC CABLE.

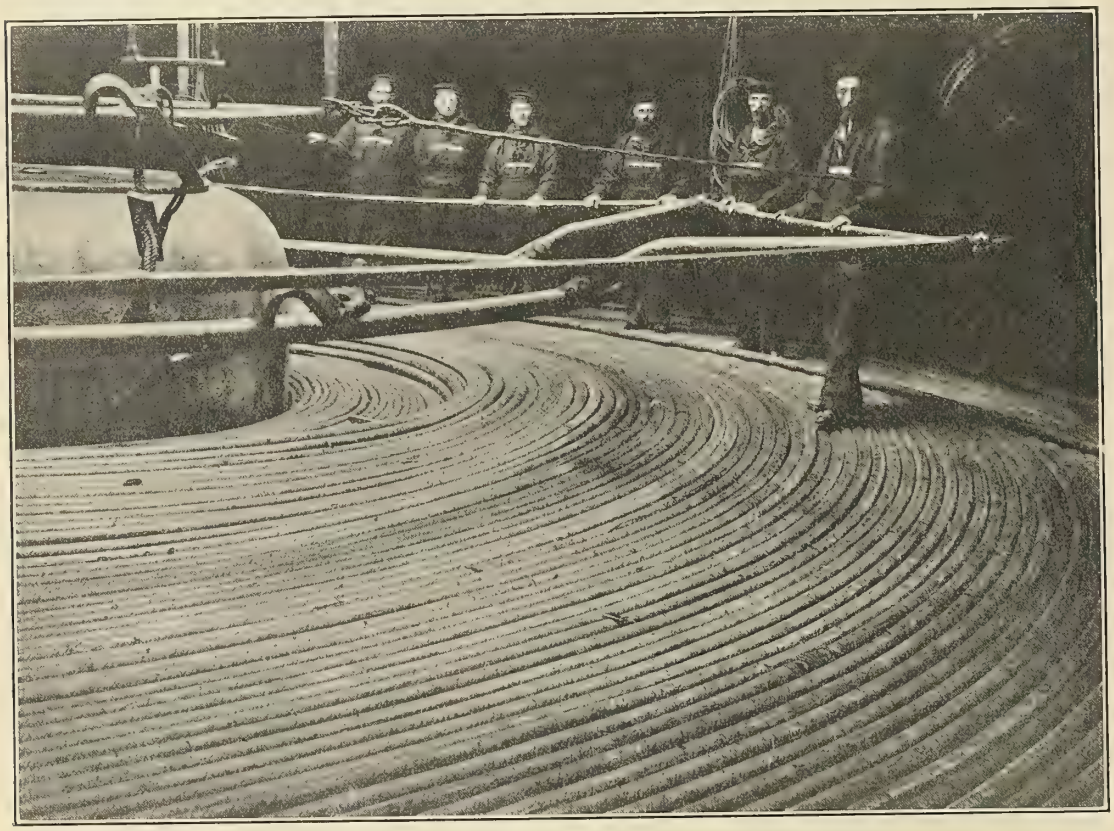


DECK VIEW ON THE SILVERTOWN, LOOKING FORWARD.

a heavy two-inch rope ashore, and then the actual landing of the cable began. Over 300 feet were paid out from the stern of the *Silvertown,* with large canvas air bags attached every few feet to float it, when it was seen that the strong current was carrying the cable away out of its course and making it almost impossible for the big team of horses on shore to move it. Darkness was coming on and the big cable ship rolling so hard that her position was really not one of safety, so the message was flagged ashore from the ship that operations must be suspended. The cable and rope were pulled back on board, and the *Silvertown* left her dangerous position, steaming in through the Golden Gate again to her original anchorage.

A new plan of campaign was then decided upon. It was seen that the assistance of a lighter-draft ship would have to be employed to land the shore end. Accordingly the steam schooner *Newsboy,* owned by the Gray Steamship Company, was chartered to take on board about six miles of the cable, the plan being for the schooner to land the shore end and then proceed to sea as far as the cable would reach, buoy the end and throw it overboard. The *Silvertown* would be nearby, pick up the end dropped by the *Newsboy,* and, after making the necessary splice, proceed on her way to Honolulu. This plan was carefully carried out on Sunday, December 14, the actual time of the landing of the shore end of the cable being 9:55 A.M., and the time that the *Silvertown* completed her work at the six-mile stopping place, before proceeding to sea, being, as before noted, 2 A.M. on the morning of the 15th.

When the *Newsboy* backed into into position about half a mile beyond the line of breakers, the light line was brought ashore as before, followed by the two-inch rope. This in turn was fastened to the cable, which was drawn to land without any difficulty, being floated by a great number of the canvas air bags, which held it suspended until, at a moment when all was in readiness, the bags with one operation were all released from their hold and floated around until picked up by the tugs in attendance. The same tidal difficulties that troubled the *Silvertown* then overtook the *Newsboy;* her anchors began to drag, and for a few moments she was in a bad fix. She was able to get under way at once, however, and soon straightened herself out on her course, proceeding to a point on the offing where the big cable ship could be seen hovering around.



HUB AND WINDING GEAR FOR CABLE IN THE HOLD OF THE SILVERTOWN.

The actual landing of the cable was made a great ceremony, the proverbial bottle of champagne being broken over the ragged end as it was drawn up on the sand, with the usual suggestive music from the bands in attendance.

After starting on her westward voyage the *Silvertown* sent daily reports to the cable station in San Francisco, and following is a memorandum of her daily runs:

To noon Dec. 15	77	knots
" " " 16	180	"
" " " 17	196	"
" " " 18	207	"
" " " 19	203	"
" " " 20	189	"
" " " 21	215	"
" " " 22	211	"
" " " 23	197	"
" " " 24	217	"
" " " 25	215	"
" 4.A.M. " 26	125	"

At 4 A.M. on the 26th of December the *Silvertown* wired back that she was about to cut the cable and buoy it in the channel off Honolulu. From that time until 11 P.M. on New Year's Day no word was heard from the other end. At the latter hour, however, communication was established with the Hawaiian Islands by the announcement that all was well, the shore end landed, and final connections made.

The deepest place recorded in this route of the Hawaiian cable is 19,116 feet. That the *Silvertown* did not find her task entirely pacific is evidenced by the noonday report received on the 17th of December, when it will be noted her daily run fell below the average:

"In latitude 34 degrees 36 minutes north, longitude 129 degrees 59 minutes west; very bad weather; high seas; seas swept over decks; slowed down at intervals; indications of weather moderating; total cable laid at noon to-day, 455 knots; total for last 24 hours, in spite of storm, 196 knots; everything O. K."

Notes on Burning Crude Oil in Scotch Boilers.

BY H. S. MARKEY.

The distillers of crude oil tell us that when oil is subjected to destructive distillation a deposit of carbon or coke is left after the hydrocarbon gases have been driven off, just as when distilling soft coal in the gasworks.

When oil is atomized in the furnaces of a Scotch boiler, the gas is evaporated from the minute globules of oil, leaving a fine carbon dust, which must burn as carbon. The combustion of carbon proceeds somewhat slowly as compared with gas, but the more finely it is divided the quicker it will burn. Now, the burning carbon dust is carried by the draft with a certain velocity through the furnace toward the back connection, and it is evident that if it is not consumed quickly it will reach the back-connection sheet still burning. In other words, if the oil is not atomized thoroughly, it will burn with a long flame and may injure the back-connection sheet and stay-bolt heads. Again, if the carbon dust is not consumed while floating in the draft, it deposits in large, red-hot masses in the back connection, and must be dug out and thrown overboard—a manifest waste of fuel.

The more thoroughly the oil is atomized the finer will be the resulting carbon dust and the quicker it will burn, hence less chance for depositing and a shorter flame. This is the all-important function of the burner or atomizer—to thoroughly atomize the oil. The so-called retort burners or internal mixers are of doubtful value, except as they make for this important requirement. Either steam or compressed air may be used as an atomizing agent, one presenting no advantage over the other so far as the combustion is concerned. Steam is the more convenient, but the prohibitive cost of fresh water at sea necessitates the use of compressors or rotary blowers aboard ship.

Crude oil, when heated, becomes considerably thinner, in which condition it is more easily atomized. A good oil heater is therefore a necessary adjunct to oil-burning apparatus. When compressed air is used for atomizing, it should be heated to avoid the cooling effect upon the oil due to the sudden expansion of the air.

The velocity with which the oil is projected from the nozzle of the burner probably has more to do with pulverizing it than any other thing. The velocity depends entirely upon the pressure, hence that type of burner is superior which has the oil and steam or air pressure right up to the discharge orifice, the supply being regulated by the size of the orifice. Compressed air at from 20 to 30 pounds per square inch gives very good results, although pressures of one pound and less have been used. This low-pressure system, as it is called, with its resultant low velocity, cannot atomize the oil so thoroughly as the high-pressure system, and, in the only installation of the kind that has come under the author's notice, great trouble was experienced from the burning off of the stay-bolt heads and the buckling of the back-connection sheets. The only advantage that can be claimed for the low-pressure system is that it costs less to compress air to one pound per square inch than to compress it to 30 pounds, but the low-pressure system undoubtedly requires more free air to atomize a given quantity of oil than the high-pressure system, which goes a long way toward neutralizing any advantage in that direction.

On the Pacific coast we allow about one cubic foot of free air drawn into the compressor to each pound of water evaporated in the boiler. In some experiments with the low-pressure systems conducted by the United States navy, it was found that from 3 to 4 cubic feet were required.

It is not always easy to find room in the fire room for the cumbersome appliances of the low-pressure system, 15 to 18-inch riveted air mains contrasting strongly with the 4 to 6-inch gas pipe mains of the high-pressure system. More or less trouble has been experienced with the air compressors, it is true, but this was due to fitting compressors unsuited to the work. Machinery that will work well enough ashore does not necessarily give satisfaction at sea, where continuity of operation is all-important. It should be remembered, also, that the capacity of a compressor is measurable to a large extent by the area of the suction valve opening. Compressors with contracted inlets will deliver no more air at 100 revolutions per minute than at 75 revolutions per minute.

The greatest trouble that has been experienced in burning oil in Scotch boilers is the burning of the stay-bolt heads and buckling of the back-connection sheets, due to the flame impinging upon them. This is especially so of short boilers. To avoid this the furnaces are sometimes lengthened by fitting sheet-iron projections lined with firebrick to their front ends.

A burner of the ordinary type, having a small circular discharge orifice, projects the oil through the center of the furnace in a sort of vaporous core composed of minute oil globules, hydrocarbon gas, carbon dust, and carbonic oxide gas, or CO, due to the partial combustion of some of the oil with the air used for atomizing. The core burns from the surface to the center and is surrounded and enclosed by the products of combustion. The air must diffuse itself through the outer gases and penetrate to the center of the core in order to completely consume it. The core, with its surrounding zones, is moving with a certain velocity through the furnace; now, if the core is small in diameter, or the

furnace long, the air will penetrate to the center of the core and consume it before any of the fuel reaches the back connection. On the other hand, if the core is of large diameter, or the furnace short, the air cannot penetrate to the center of the core in time to prevent some of the fuel from burning on the back-connection sheet. The remedy is to reduce the diameter of the core, or, in other words, to "cut down" or "throttle" the burner until the flame does not reach the back connection. It will then be necessary to put in more burners in order to work the boiler to its capacity. In other words, a short boiler should have three or four small burners in each furnace, while a longer boiler may be fitted with fewer and larger burners.

We have on the Pacific coast three patented burners, the salient feature of which has evidently been overlooked by the patentees, or else is not patentable, for it is common to all three. It consists of a cone or inverted valve placed in the discharge orifice with the apex against the flow of the jet, so that the atomized oil is projected in all directions in a thin sheet, shaped like the surface of a cone, with the apex at the burner. The fuel thus presents a large surface of little thickness to the air, and is quickly consumed, making the desired short flame. If the air could be introduced into the inside of the cone, combustion might proceed even more rapidly.

An engineer of the author's acquaintance, realizing the above principle, carried it out as follows: His burners were of the type known to the oil-burning faculty as retort burners, which means that in the interior are many devious and intricate passages in which the steam and oil act and react upon each other in a complex manner. After the mysterious mixing and retorting the resulting product is discharged from a nozzle which, in the burner under consideration, has a slotted aperture, like an ordinary illuminating gas burner. The burner is placed on the bottom of the furnace and the nozzle turned up with the slot crosswise with the furnace. This causes a thin wall of fuel to be projected right across the furnace, presenting a large surface to the incoming air and allowing none of it to pass the burner without coming in contact with the fuel. The distance from the nozzle to the back-connection sheet is only 8 feet, and, though 350 pounds of oil per hour are burned in each furnace, no trouble has been experienced with stay-bolt heads or back-connection sheets.

There is no reason why heated draft from a Howden or other system cannot be used with oil as with coal, and with good results. But as a smaller surplus of air is required when burning oil, a less percentage of gain would be effected.

Shipbuilding in Great Britain.—The summary of the shipbuilding returns for the United Kingdom for 1902 shows that the output of new launches was much lower than that of the previous year. A total of 823 vessels of 1,451,995 gross tons was launched, as compared with 672 vessels of 1,671,798 gross tons in 1901. It is stated that the outlook for shipbuilding for the present year is not encouraging, as there is absolutely no demand for new ships of the ordinary tramp variety, notwithstanding that builders have reduced their prices materially.

THE VIBRATIONS OF STEAMSHIPS, WITH SPECIAL REFERENCE TO THOSE OF SECOND AND HIGHER PERIOD.—I.*

BY REAR ADMIRAL GEO. W. MELVILLE, ENGINEER-IN-CHIEF, U. S. NAVY.

INTRODUCTION.

At the close of my reply to the discussion of last year on the balancing of engines, I promised to try to clear up the question of the importance of vibrations of periods higher than the first. Indeed, I was much surprised that my paper had failed to be convincing on this crucial point. The whole discussion was left in a very unsatisfactory state. All that I said in my paper was of no value unless these shorter period vibrations were an essentially important feature of the problem, and arose in large part from the unbalanced forces of the engine. Those who differed from me were far from definite in their views. Mr. Taylor,† while advocating almost exclusively the Yarrow-Schlick-Tweedy system, admitted its imperfect balance, and inadequateness if second period moments have to be balanced. And, while his advocacy seemed to imply a perfectly definite belief, in the reply to the discussion he explicitly disclaims having expressed an opinion.

During the last twelve months I have given great attention to the whole subject, and have had the literature on it, both in English and German, thoroughly examined. As a result, I have communicated to *Engineering*, in London, a very long discussion—much too long to be appropriate for a paper before a technical society. Here we need do little more than notice, as concisely as possible, the one point left in dispute from last year.

But there are two minor points which it will clear the ground to touch upon:

VIBRATORY EFFECTS FROM PROPELLER.

1st. The propeller has been made the scapegoat for much which, I think, should properly be charged to the engines. For instance, Mr. Taylor cites three separate ways in which the propeller *may* cause vibration:

(*a*) Due to the water not having a free run to the propeller (which is clearly due to the form of the hull).

(*b*) Due to one or more of the blades being out of true.

(*c*) Due to the propeller being unbalanced.

(*a*) In my paper of last year I referred to Yarrow's experiments which, to him, afforded "overwhelming proof" that the propeller did not affect the vibration of the torpedo boat. But Mr. Taylor points out that the conclusion does not necessarily hold for ships which have not "fine lines, a fine run." True, but the question of hull vibration did not become prominent till we had very full-powered ships, and these, I think, without exception, have fine lines. They are, in a large proportion of cases, twin screws, where the water has the freest access to the propeller. If in Mr. Yarrow's torpedo-boat experiments there was no influence present, it could never be very much in any even moderately fine-lined vessel.

(*b*) With built-up propellers, in cases of any importance, the blades are set carefully to pitch, and still

*Read at the meeting of the Society of Naval Architects and Marine Engineers, New York, November, 1902.

† Mr. Taylor's paper given in Marine Engineering, January and February, 1902.

vibration occurs. In solid propellers, suppose that by careless casting the pitches vary for the different blades. Then the forces induced would be almost entirely of first period and consequently concern us little here. But I do not believe the explanation is well founded, for we have the pitches of the various blades of solid propellers measured regularly, and they very rarely reveal important variations. If made of bronze they are corrected.

(*c*) Propellers for high-speed ships are almost invariably balanced (in naval work they are always balanced). But where this obvious precaution is omitted, any degree of unbalance reasonably supposable gives rise only to forces of comparatively small amount. Let us take the case of the *Deutschland*. Her propellers are built up, having four blades, and are 23 feet 3 3-4 inches in diameter. One whole propeller will, therefore, weigh about 27 tons and one blade about 4 1-2 tons. It would be far beyond reasonable supposition to take one blade as 25 per cent. heavy. But this would give about 1 1-8 tons at a radius of about 6 feet, or 2 1-2 tons at crank radius. I find the mass, at crank radius, for cranks II and III to be 32 tons. Hence this extravagant supposition only amounts to leaving about one-fourteenth of one of these cranks unbalanced; or, counting the forces at the propeller twice as favorably placed for producing vibration as at the engine, this fraction becomes one-seventh. Not a very important amount. Let all propellers for high-speed ships be balanced, however.

The effect of the propeller on vibration has unfortunately been the subject of much mere speculation, when a few simple measurements would have convicted it or acquitted it of the crimes with which it is charged. The only point which seems to be fairly established is that it is frequently the cause of horizontal vibrations, occasionally severe; for these are usually of third or fourth period, according as the propeller has three or four blades. Occasionally the double period has been noticed. Also the jarring of the shaft in the stern bearing may be, to some extent, referred to the propeller, but this action takes place more intensely when the engine is vibrating the ship severely.

May we not, then, dismiss the propeller as being a factor of small importance with engines at any usual speed of revolution?

POSSIBLE HIGH FREQUENCY OF VIBRATIONS.

2d. In section 3 of his paper Mr. Taylor says, "There is probably a limit to the frequency with which actual ships can vibrate, but there is little positively known on this point." I know of no physical cause limiting the speed of vibration. I need only refer again to the quotation I made, in my reply to the discussion, from Mallock's observations, where he noted vibrations as high as 1,950 per minute. Any one who has been in the hold of a ship that was being riveted up receives peremptory proof from the deafening noise of all pitches that there are modes of vibrations of the structure for which the frequency ranges up to many thousands per minute.

I will now deal very briefly with three vital questions:

1st. Do important vibrations of second and higher period occur?

2d. Are the unbalanced forces of higher period in the four-crank engine important?

3d. Are the forces of higher period sufficient to account for the vibrations of corresponding period?

Do Important Vibrations of Second and Higher Period Occur?

RECENT INVESTIGATIONS.

This seemed to be a subject of great doubt in the discussion of last year. Happily it is now possible to prove, not only their occurrence, but great importance, by reference to careful observation.

Since 1893 the German Navy Department has regularly undertaken the measurement of vibrations in all new warships, by means of Schlick's pallograph. An account of some of these investigations and a large number of pallograms will be found in a paper by G. Berling, Imperial Naval Constructor, published in the *Jahrbuch der Schiffbautechnischen Gesellschaft,* vol. ii., 1901, p. 373—"Comparative measurements of ship vibrations on the *Hansa* and *Vineta,* cruisers of the German navy." Berling's investigation dealt largely with a comparison of the action of the Schlick engine and the ordinary four-crank engine. It is, therefore, of special interest for us here in view of last year's discussion.

A pallogram is a line drawn by the pallograph on a strip of paper moving uniformly with the time. It records at each instant, very closely, the displacement, due to vibration, of the part of the ship at which the instrument is placed. It is thus a record, on a time base, of the vibratory movement of one particular part of the ship. When the pallograph is properly placed, one pencil records the vertical transverse vibrations, and one the horizontal; while a third pencil marks seconds.

SYNTHESIS AND INTERPRETATION OF A PALLOGRAM.

Let us first build up a few pallograms. We shall then be able to interpret clearly those drawn by the vibrating ships and appreciate the strong and definite evidence they bear. We shall also be led to assign a meaning to the term "Vibrations of Equal Importance" when dealing with more than one period.

Fig. 1 is a pure sine curve, and represents a vibration of a single period. Suppose it has one inch total travel occurring 100 times per minute. This we will take as our unit vibration, in which $S = 1$ and $n = 100$, S and n denoting the travel and frequency. If a body, of mass m, is submitted to this vibration it can at once be determined that the maximum inertia force, at each end of the travel, will be—

$F = .142m$, and for a vibration occurring n times per minute, and having travel S,

$$\frac{F}{m} = 1.42 \times 10^{-5} \times n^2 S.$$

F being in pounds weight if m is in pounds.

That is, a person weighing 160 pounds standing on a deck vibrating vertically thus would experience a variation of pressure on the soles of his feet, above and below his weight, of 22.7 pounds, $160 - 22.7 = 137.3$ pounds when at the highest point of vibration, and $160 + 22.7 = 182.7$ pounds at the lowest. This would be quite an important vibration. To the vibration of Fig. 1 add one of 200 per minute, $n = 200$. Take $S = 1$-2 inch and make both vibrations come to upward

maximum displacement at the same time. Fig. 2 shows the vibrations separately, and Fig. 3 the combined vibrations.

Note that in Fig. 3 the value of S for first period is given by the vertical distance between the two maxima C and D, not by the total travel.

In Fig. 4. for the second period vibration, $S = 1\text{-}4$ inch.

In Fig. 5, for the second period vibration, $S = 1\text{-}8$ inch.

In Fig. 4 the maximum forces for first and second period vibrations are equal, but the latter is applied twice as often as the former, and on that account could not fail to be much more annoying.

I take, all through this paper, as a measure of the importance of a vibration the value of

Force × frequency,

and in my paper for *Engineering* I give reasons which, I believe, show it to be a fairly satisfactory measure. Therefore, in Figs. 3, 4, and 5 the relative importance of the second period vibrations compared with those of first period are 4, 2, and 1, respectively, as noted on the figures. If, now, to Fig. 4 we add a fourth period vibration of one-sixteenth of an inch, starting with a maximum upward displacement, we get Fig. 6. Comparing it with Fig. 4, the crests are just a little sharper and the hollows slightly notched upward at the bottom.

Figs. 7 and 8 are derived from Fig. 2 by shifting the second period curve to the right by one-eighth and one-fourth of its period, respectively. In both these cases the downward movement differs from the upward. In Fig. 9 we have first and third period combined, and this gives us a pallogram symmetrical about the base line. An infinite variety of pallograms could be produced, but these will serve our purpose.

What do these illustrations teach? Unless force × frequency for short period vibration is relatively very large, as in Figs. 3, 6, and 8, the number of crests will correspond to the fundamental vibration. In Fig. 9, where the ratio of force × frequency is 3, the short period cannot nearly produce crests, only sharpening those of the fundamental vibration. If the pallogram departs sensibly from a sine curve, short period vibrations are prominently present. For instance, if Fig. 5 were drawn to the size of any of the pallograms given below, its departure from a true sine curve would not be observable. Yet here the second period vibration is as important as the first, and to any one on deck the difference of bodily sensation would be very marked.

If the relation of epochs or phases changes, the shape of the resultant curve undergoes a marked change, as is seen by comparing Figs. 3, 7, and 8. And a marked change will often follow from a temporary change in the magnitude of one of the component vibrations.

We have usually, then, to depend on two features for evidence of short period vibrations:

1st. Departure from a true sine curve.

2d. Progressive change of shape.

BERLING'S PALLOGRAMS AND WHAT THEY TEACH.

Let us now examine a few of Berling's many admirable pallograms.* Figs. 10 and 11 are from the *Kaiserin Augusta,* a three-screw ship, with three cylinder engines having cranks at 120 degrees. Fig. 10 is with three screws at 102 revolutions, the pallogram being taken on the upper deck at frame 103. The upper line in all pallograms gives the vertical vibrations

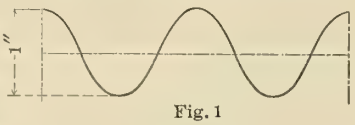


Fig. 1

$s = 1$ inch
$n = 100$ per minute
$\frac{F}{m} = .142$

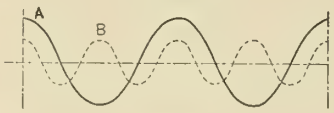


Fig. 2

	1st period.	2nd period
s	1	.5
n	100	200
$\frac{F}{m}$	.142	.284

A=1st period. B=2nd period

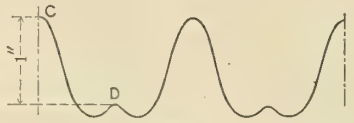


Fig. 3 *Marine Engineering*

	1st period.	2nd period
s	1	.5
n	100	200
$\frac{F}{m}$	.142	.284

Force x frequency 1 to 4

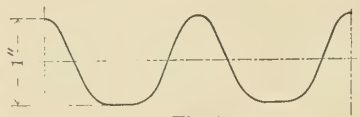


Fig. 4

Period	1st	2nd
s	1	.25
n	100	200
$\frac{F}{m}$	.142	.142

Force x frequency 1 to 2

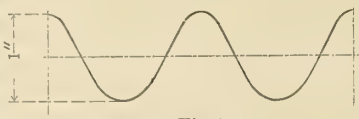


Fig. 5

Period	1st	2nd
s	1	.125
n	100	200
$\frac{F}{m}$	.142	.071

Force x frequency 1 to 1

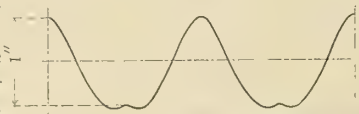


Fig. 6 *Marine Engineering*

Period	1st	2nd	4th
s	1	.25	.0625
n	100	200	400
$\frac{F}{m}$	.142	.142	.142

Force x frequency 1 2 4

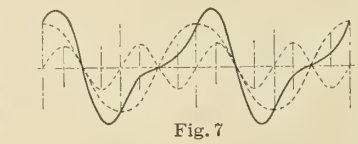


Fig. 7

Period	1st	2nd
s	1	.5
n	100	200
$\frac{F}{m}$	.142	.284

Force x frequency 1 to 4

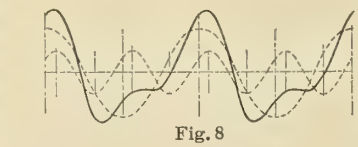


Fig. 8

Period	1st	2nd
s	1	.5
n	100	200
$\frac{F}{m}$	.142	.284

Force x frequency 1 to 4

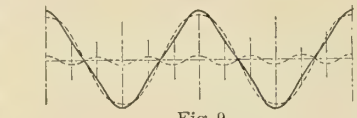


Fig. 9 *Marine Engineering*

Period	1st	3rd
s	1	.111
n	100	300
$\frac{F}{m}$	.142	.142

Force x frequency 1 to 3

of the instrument, the lower line the horizontal vibrations, and the middle line marks seconds. At every five seconds there is a longer downward stroke.

*Berling, in his paper, gives a careful account of the comparative measurements already referred to, which were carried out under his superintendence. Further discussion of the results and much additional information regarding the ships is found in the papers of von Jaski and Mohr, *Schiffbau,* 1900 and 1901.

Most of the vertical vibration is a fairly pure sine curve, though at some parts the crests are much more rounded than the hollows, indicating a considerable second period vibration. Here, as in most of the pallograms, one would at first sight, from counting the crests, be apt to assert the presence of first period vibration only, but we have seen above that more careful thought will interpret the diagram differently. The maximum vibration is 16 millimeters, or .63 inch.

Taking the value of force × frequency in Fig. 1 as unity, and calling its value for any other vibration V, we get

$$V = \frac{n^2 s \times n}{100^2 \times 1 \times 100} = \frac{n^3 s}{10^6}, \qquad (1)$$

or, if s is given in millimeters,

$$V = \frac{n^3 s}{25.4 \times 10^6}. \qquad (2)$$

Similarly, the ratio of the maximum forces or accelerations is

$$A = \frac{n^2 s}{100^2 \times 1} = \frac{n^2 s}{10^4}. \qquad (3)$$

or, with s in millimeters,

$$A = \frac{n^2 s}{25.4 \times 10^4}. \qquad (4)$$

Hence, in Fig. 10, we have

$$V = \frac{102^3 \times 16}{10^6 \times 25.4} = .67. \quad A = \frac{.67}{1.02} = .66.$$

The change in amplitude during the observation is as explained above. This change was very probably due to a slight change in the speed of revolution during the minute and a half of observation; thus producing at one time a more near approach, at another a less near approach to synchronism, in both of the vibrations, the change toward or from synchronism being naturally different for the two periods. As is well known, a change toward perfect synchronism produces not only an increase of amplitude, but a change of the epoch of the response relative to the epoch of the exciting

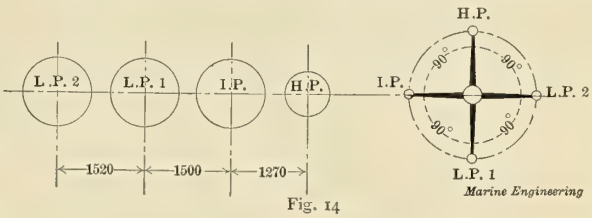


Fig. 14

force or moment. Slight difference of speeds of the two engines may also have had something to do with the result.

By comparing with Fig. 3 we see the value of s for first period, at the beginning of Fig. 11, is not 5.5 millimeters, but must be measured from the lowest point up to the bottom of the little notch at the top. Say s = about 4.5 millimeters. Then

$$V = \frac{105^3 \times 4.5}{10^6 \times 25.4} = .21 \quad A = \frac{.21}{1.05} = 20.$$

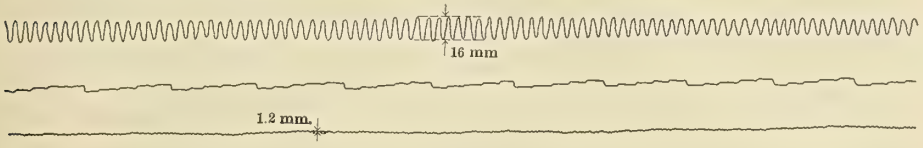


Fig. 10 S.M.S. KAISERIN AUGUSTA. 3 SCREWS, 102 REV'S, UPPER DECK, FRAME 103.

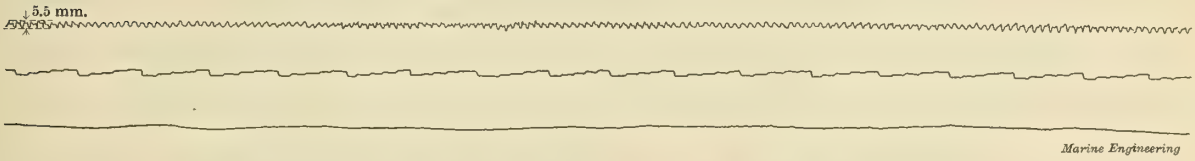


Fig. 11 S.M.S. KAISERIN AUGUSTA. 2 SCREWS, 105 REV'S, UPPER DECK, FRAME 1.

probably due to the three engines not running at precisely the same speed, possibly to a slight change of speed in all. The horizontal vibration is of third period, and, no doubt, arises from the three-bladed propellers. I will not notice these horizontal vibrations further in this paper .

Fig. 11 was obtained from two screws, at the upper deck, frame 1, 105 revolutions. The vertical vibration here is a beautiful example of the simultaneous existence of first and second period vibrations, the latter being much the more important, as is shown by comparison with Figs. 3, 7, and 8. All these figures are closely imitated at the different parts of the pallogram, showing that during the observation there were changes of the phase relationship of the two sets of vibrations,

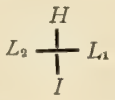
The comparison with Fig. 3 also shows that at this point the second period vibration must have had a value of V considerably over four times that just given for the first period, say, at least,

$$V = .21 \times 5 = 1.05.$$

In the *Kaiserin Augusta*, then, the second period vibration is much more severe than that of first period, though the forces and moments which produce the former are much the smaller. I will return to the point toward the end of this paper, and show that this is exactly what might be expected.

Figs. 12 and 13 are pallograms from the *Vineta* and *Hansa*, respectively. The *Hertha, Hansa,* and *Vineta* are sister ships (Berling, page 374), the *Hertha* and *Hansa* having Schlick engines and the *Vineta* four-

crank engines arranged, according to Berling, as in Fig. 14; though the more recent papers of von Jaski and Inch* give the ordinary arrangement of contiguous cranks opposite



If Berling is correct, the opposite cranks of the *Vineta* not being contiguous, a more than usually strong first period couple will be produced, while that of second period will be less than usual. Pallograms reproduced are the worst given by Berling in each case, and he mentions from 120 to 140 revolutions as those giving greatest vibration. A considerable part of the upper curve of Fig. 12 shows a fairly pure sine curve; though other parts, as we would expect, indicate pronounced second period vibrations. Berling, however, speaks only of experiencing first period vibration, and does not mention any other.

Fig. 13 shows principally second and still higher period vibrations, as we expect from the Schlick engine. However, at several places, notably about five seconds from the beginning of the observation, first period is also present, possibly due to want of perfect rigidity in the engine seat. Close examination of this pallogram shows, inverted, the sharp crests and well-rounded hollows even more marked than in Fig. 4, indicating the presence of, relatively, very strong fourth and higher period vibrations.

The relative values of the vibrations are:

	S.	Rev.	*n.*	*V.*	*A.*	Period.
Vineta..	4.7	137	137	.48	.35	1st.
Hansa.....	3.5	140	280	3.02	1.08	2d.

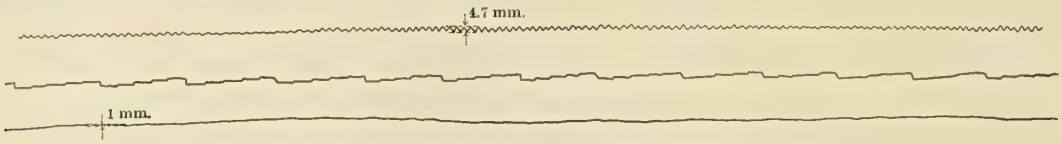


Fig.12 S.M.S. VINETA, 3 SCREWS: 136-137 REV'S, BETWEEN DECKS, FRAME 2.

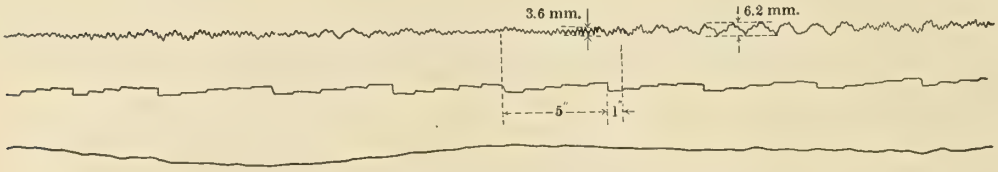


Fig.13 S.M.S. HANSA, 140 REV'S, UPPER DECK, FRAME 7

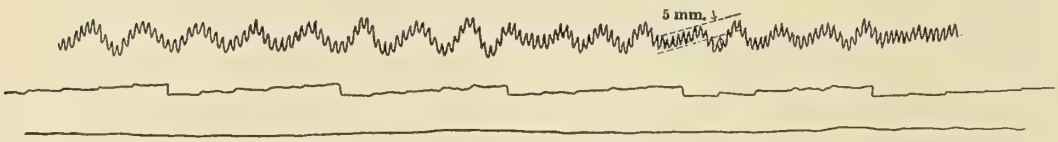


Fig.15 S.M.S. TORPEDO BOAT S.42 235 REVS.

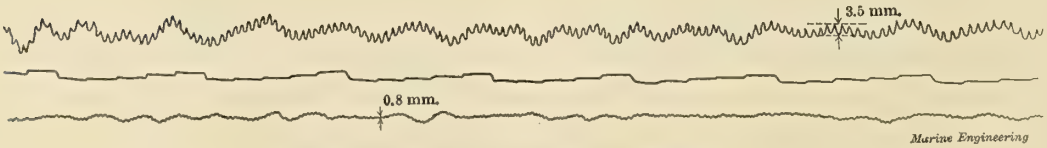


Fig.16 S.M.S. TORPEDO BOAT S.42 250 REVS.

Thus V is over six times and A three times as large in the ship with the "balanced" engine, and this takes no account of the still stronger fourth period vibration of the Hansa!

Figs. 15 and 16 are from torpedo boat *S. 42* of the German navy, when it had Schlick engines. Fig. 15 is difficult to understand, as it seems to indicate 310 or 320 revolutions rather than 235, as marked. Hence, I pass it over, though it shows a severer vibration than any other pallogram given by Berling for this ship.

The next in magnitude I give in Fig. 16. Here we

*American Society of Naval Engineers, vol. xiv., pp. 22, 33, 213.

have the well-marked divergence from a sine curve shown by the sharp crests and well-rounded hollows as in Fig. 4. Thus we have, more marked than in the *Hansa*, first period vibrations. But the shape of the curve indicates much more severe vibrations of second period; and, consequently, it is not surprising that Berling, and also Mohr in his paper,* both speak of the second and not of the first period.

For first period we have—

$$V = \frac{250^3 \times 3.5}{25.4 \times 10^6} = 2.15 \qquad A = \frac{2.15}{2.5} = .86.$$

The value of V for second period it is impossible to assign, but comparison with Fig. 4 indicates that it is more than twice as large as the value just given.

Torpedo-boat *S. 42* had first a three-crank (unbalanced) engine, the cranks being at 120 degrees. This, for reasons not explained, was replaced by a four-crank (unbalanced) engine with cranks at right angles, which seems to have produced severe vibration, as it was rebuilt and "balanced" from data by Schlick. We are further informed by von Jaski† that " the engine was so faulty that the boat with the Schlick engine could not be used in squadron evolutions, and had once more to get a shaft with cranks at right angles. Furthermore, the end sought—to reduce the vibrations of the hull by counterbalancing the free vertical forces and the rocking moments—was not obtained; on the contrary the vibrations were very much greater."

Mohr's statement (which occurs in his paper on the balanced and unbalanced engines of torpedo boat *S. 42*) is to the same effect. The evidence from this experiment is most conclusive.

Berling ingeniously explains these second period vibrations by the action of the propeller; apparently not noticing the strong second period moment of the Schlick engine. I have dealt fully with the question in my paper written for *Engineering*, and I think I have conclusively demonstrated that the propeller would not produce the effects attributed to it, while the forces of the engine afford ample explanation. These second period vibrations were found in all cases with Schlick engines, as the following quotation from Berling (p. 389) shows:

"This fact (second period vibration) does not stand isolated, but is confirmed by other sister ships of the investigated class, the cruisers *Hertha* and *Victoria Luise* and torpedo boat *S. 42*, which ships are all fitted with Schlick engines."

It could hardly be otherwise. Mohr is perfectly clear with regard to second period vibrations, as a few quotations will show. The first I give begins with a comparison of the first and second period forces and moments for *Vineta, Hertha,* and *Victoria Luise*.‡ As the comparison is made at the same value of $\omega^2 R$, the values for the *Hertha* would have to be reduced one-sixteenth to make it for the same piston speed, as her stroke is 800 millimeters, while that of the other two is 750 millimeters.

[Mohr, p. 283.]

	1st Order.		2d Order.	
	Free Force. kg.	Free Moment. mkg.	Free Force. kg.	Free Moment. mkg.
Vineta.....	2495	27200	677	18420
Hertha.....	Vanishing.	Vanishing.	**4750**	**35950**
Victoria Luise	Vanishing.	Vanishing.	**5420**	**30000**

"From the enormous magnitude of the forces and moments of the second order in balanced engines it may be clearly seen that they are the principal cause of the observed *'Vibrations of a double period.'* Perhaps their action is still further increased by the variable propeller thrust. *The free force of 2,495 kilogrammes and the free moment of 27,200 millikilogrammes in the engine of the Vineta are indeed removed by the Schlick method of balancing in the other two engines; but in their stead the forces of the second order,* THAT OCCUR TWICE AS FREQUENTLY,§ *are considerably larger, even still larger than the forces and moments of the first order that were to be removed.* This faulty balancing of the forces of the second order is probably also the cause of the considerable vibrations of our large ocean liners, that are provided with 'balanced' engines. More than by the exact comparison of the two engines of *S. 42*, has this superficial comparison of the large engines of our cruisers proven that a balancing of a four-crank engine without regard to the finite length of the connecting rod, *i.e.*, without regard to the inertia forces of the double period, is, indeed, no balancing at all; that, on the contrary, it is absolutely necessary to consider the forces of the second order more or less, as the circumstances may demand."

This is precisely the ground I stand on. It is the ground my friend Macalpine took many years ago and is one of the essentials on which his system is founded.

(To be continued.)

Shipyard Failures.—The Moss Iron Works and Dry-Dock Company, Brooklyn, N. Y., has found it necessary to ask for an extension of time on $450,000 worth of commercial paper. The statement given out to the public is that owing to heavy government contracts on which the money is paid slowly, the company is temporarily embarrassed.

The William R. Trigg Company, shipbuilders, Richmond, Va., applied for a receiver the latter part of December. It is understood that the company has lost money on government and private contracts.

*Comparison between the balanced and unbalanced engines of torpedo-boat *S. 42*, by Hans Mohr, *Schiffbau* II, January 8, 1901, p. 237.

†Results of Investigations of Recent Engines of the German Navy, by Chief Constructor Köhn von Jaski, *Schiffbau*, June 8, 1900, p. 507; Translation, *Journal American Society Naval Engineers*, vol. xiv., p. 18.

‡ Mohr's figures, as given in the table immediately following, make the case stronger than I would have expected, but it is impossible to check them for want of sufficient data, and the doubt as to the crank sequence of the *Vineta*. He says, regarding his calculations: "As a comparison, only, is under consideration in this case, the vertically vibrating and rotating masses are not separated. . . ." Surely he has not included the rotating masses in making his calculations for second period!

The matter is of little importance here, as his conclusions are amply justified by the figures for the *Deutschland*, but I have given his figures to make the rest of the quotation intelligible.

§The emphasis is Mohr's.

GAS ENGINES AND THEIR TROUBLES.—VIII.

BY E. W. ROBERTS.

Preparing for a Cruise.

When starting upon a long trip with a motor boat it is the wisest plan to anticipate any trouble that would be likely to arise by being prepared with tools and extra parts to cope with any emergency. It is assumed, of course, that the operator has had previous experience and that he will not undertake an extended journey without at least having become somewhat familiar with the operation of his boat in his home waters. In selecting the supplies and tools that you are likely to need, do not scorn any possible necessity by assuring yourself that there is a very small chance of any certain part being broken. Remember that it is the expected that often happens the least. What we are not looking for is generally what we have to contend with.

Take the following example: I once sold a boat, as agent, to a college professor for his explorations in search of fossil shells. As much of his work was in shallow waters, he was compelled to get a stern-wheeler. This boat was so constructed that the power was taken from the engine to the wheel by a chain running free and unguarded over the water for about three feet. I suggested placing a trough under this chain, so that it would not go overboard if it broke. But I was promptly informed that the chain was the very last thing that would break and that he would take the chances at any rate. Poor, deluded professor! that chain broke in less than two weeks and when he was in the middle of a lake a mile wide. Sure enough, it went overboard as I had prophesied, and it took nearly a week to get a new chain. The next chain had a trough put under it.

SPARE PARTS.

In the matter of extra parts that should be taken on a trip, it is hard to give a definite list, as the construction of engines varies so much. It might be said in general, however, that the igniter, having the smallest and most delicate parts, is the most likely to become deranged. It is an excellent plan to take at least one full set of igniter parts, and if the engine has more than two cylinders, or if the trip is to be a long one, two complete sets of repairs should be carried with you. The moving parts are those most likely to break or get out of order. Springs quite often become weak or break, and especially, should flat springs be used, a full set should be in the repair kit. Always make sure to have extra insulation and any such little items, as screws, washers, nuts, and cotter pins. Wire for carrying current is often broken and a new wire will generally make a more satisfactory repair than a spliced one, so that it is quite handy to have plenty of wire. The best wire for igniter purposes is No. 14 stranded conductor. In case ignition is by jump spark, a full set of plugs should be carried for a tour of any extent, as should springs and all parts of the circuit breaker.

DYNAMO AND BATTERY.

The dynamo and the battery require their modicum of attention and for them the supplies should be carefully considered. For the dynamo or magneto there should be extra brushes and brush springs, and for a long trip perhaps an extra commutator. For the battery there should be a complete set of spares, if of the wet type, or a complete set of new cells if a dry battery is employed. The plan of having a spare battery already connected up, as explained in Chapter VI, is a good one, but extras should be carried in addition to the spare battery.

The vaporizer is of such varied construction that it is difficult to point out what supplies it would require. For those with valves, new valves should be carried, since the seats wear out and the prongs that guide the valve break off. Those of the float-feed variety, with atomizer or nozzle, seldom have moving parts, and only the delicate pieces which are so exposed as to be easily broken require replacing. The needle valve which controls the gasoline is probably the part that will be broken or bent more than any other, and an extra one might be found convenient.

ENGINE SUPPLIES.

Supplies for the engine proper which it would be wise to carry are extra valve springs for a four-cycle engine, and possibly an extra valve. The connecting rod is not a part that will give out very often, but occasionally one will break owing to a flaw or neglect to take up lost motion, and then you are in a peck of trouble. Thin sheet asbestos for packing should always be on board a gasoline launch. It should be of good quality and thin, not over 1-32 inch thick. Thicker packing will answer in a pinch, but is not apt to hold so well. A four-ounce bottle of orange shellac dissolved in grain alcohol, and a half-inch brush, will be found convenient. It is to be used for coating the surface of a joint before putting on the asbestos packing. Don't use white shellac or shellac that has been dissolved in wood alcohol. A small piece of common brown soap will be found handy for lubricating the joints of the gasoline connections if they have to be taken apart. Should you have no soap, shellac will answer, although it makes the joint a little harder to unscrew. Always keep some lamp wicking for packing the stem of the needle valve. This wicking should always be moistened with soap and never with oil. Another important item of supplies is an assortment of nuts, bolts, cap screws, and machine screws of the various kinds used on the engine.

The reversing mechanism and any other mechanical adjuncts, such as an air pump for the starting tank, should not be overlooked. Perhaps the novice will be surprised to find that I recommend the carrying of a spare propeller. However, the gasoline boat is one that is frequently knocking about along unfamiliar shores where a hidden spile is apt to relieve the propeller of a fluke or two. Twice in two weeks I started out with a four-bladed propeller and returned with a two-bladed screw. The second time it happened I decided to use a two-bladed propeller, with no perceptible change in the performance of the boat except that it was a little bit sluggish about getting under way.

TOOL KIT.

For the tool box the following is a good equipment: A twelve-inch monkey wrench or automobile wrench, a bicycle wrench, a ten-inch Stillson pipe wrench, a pair of gas pliers, a 1 1-4-pound machinist's hammer, a ten-inch machine screwdriver, a four-inch machine screwdriver, a hatchet, an assortment of nails, and a

coil of electric tape. Besides the above necessary equipment, you may find it convenient to have a brace with a few bits, and a twist drill or so for drilling out broken bolts or set screws. Two oil cans, one with a long spout and another with a short spout, and possibly a force-feed oiler for getting into tight corners, should be part of the kit. Two or three good cold chisels and several files, including a round, a half-round, and a coarse flat file, should form a part of the equipment.

BOAT EQUIPMENT AND SUNDRIES.

Then there are a few other articles, not strictly allied to the mechanical equipment, which my experience as a launch owner has proven to be desirable. One of these is a pike pole. An idiot of a steersman once ran me deliberately into a sandbar in a narrow inlet within twenty feet of a charge of dynamite on which the fuse had already been lighted. Of course I didn't have a pole, and pulled off my shoes and rolled up my trousers in something like fifteen seconds. I got around the bend just as the dynamite let go. I had a similar experience, with the dynamite omitted, on the Maumee river with a non-reversible engine. We had no pole, but fortunately there were no ladies along, so one of the boys stripped and went in.

Another handy tool for shallow waters is a sharp-bladed hook for cutting eel grass off the propeller. When the direction of the propeller's rotation may be reversed, the grass may often be thrown off by running the wheel back and forward, but with the reversing propeller it is not so easy. If the boat has a long fantail and considerable freeboard, there is no fun in hanging over the stern and pulling the grass off with your hands, and still less in stripping off your clothes and diving for it.

Something to carry gasoline in, such as a five-gallon can, will be found handy in country districts. A funnel is not absolutely necessary, but will often save spilling the gasoline when filling the tank. Should you use a belt-driven dynamo you should have some No. 22 copper wire for sewing the belt and an extra piece of belting. I have found a speed indicator convenient at times for testing the speed of the engine, to see if it was working at its best.

Always make sure before starting out that your supplies are ample. Neglect of this precaution is often the cause of much inconvenience. Make it a point to go over them carefully, and see to it that you have plenty of gasoline, gas-engine oil, and cup grease. Should you at any time get out of any of these supplies, you may run your engine on kerosene, if it is already warm and you can put up with a little smoke. Vaseline may be substituted for cup grease, but nothing but the lightest of cylinder oils should be used for the engine.

When you are satisfied that you are well supplied with everything you need, make certain that the engine is in good running order. Go over every part from the propeller to the flywheel and don't neglect a nut or a screw. Above all things see that your connecting rods are well adjusted and that the bolts are tightened up snugly. If the engine is not clean, wipe it up, and look to the cylinder and the exhaust passages that they are not sooted up. See that your oil cups feed freely and that there is the proper height of oil in the crank case. Screw up the gland on the propeller-shaft stuffing box, and, if it is nearly up to the end of the threads on the nuts, repack it.

The igniter system should have the most careful attention. The battery should be tested to see if it is weak, and the wire should be tested for both open and closed circuits, and every binding-post screw tightened up. Then test the springs, and if there is an adjustment needed do not neglect to make it.

Finally, should anything have been overlooked in the above summary, do not think you will not need it, if you have found it useful before. The prime object to be kept in view in a preparation of this kind is so to make ready that you may proceed with your trip as independent of outside help or repairs as possible.

(To be continued.)

Safety-Valve Springs.

BY H. K. SPENCER, U. S. R. C. S.

As springs are always used for loading the safety valves of marine boilers, it is well to consider how such springs are proportioned.

The duty safety-valve springs must perform is that, first, they are compressed an amount sufficient to resist the working load on the valve, and then must be able to withstand a still further compression equal to one-eighth the diameter of the valve opening.

A load applied to a helical spring puts the material under a torsional stress. The formulæ given below are derived from the simple torsion formulæ giving the strength and stiffness of members under torsional stress, and those for square steel are modified, as they should be, by the results obtained by St. Venant from his investigations as to the comparative stiffness of round and square shafting. The constants employed were obtained experimentally. The springs tested were such as are commonly used in shaft governors, and were not so carefully made and tempered as are safety-valve springs, so the figure given for the elastic limit is possibly a little low for carefully-tempered spring steel. Within the elastic limit of the material, for each increment of load the increment of extension or compression was found to be quite uniform—*i. e.*, if a load of 100 pounds extends or compresses the spring 0.1 inch, a load of 200 pounds will extend or compress it 0.2 inch; a load of 300 pounds, 0.3 inch, and so on, each additional 100 pounds increasing the extension or compression by 0.1 inch until the elastic limit is reached.

The formulæ are given for both round and square steel, although square steel is almost always used for safety-valve springs. The notation is:

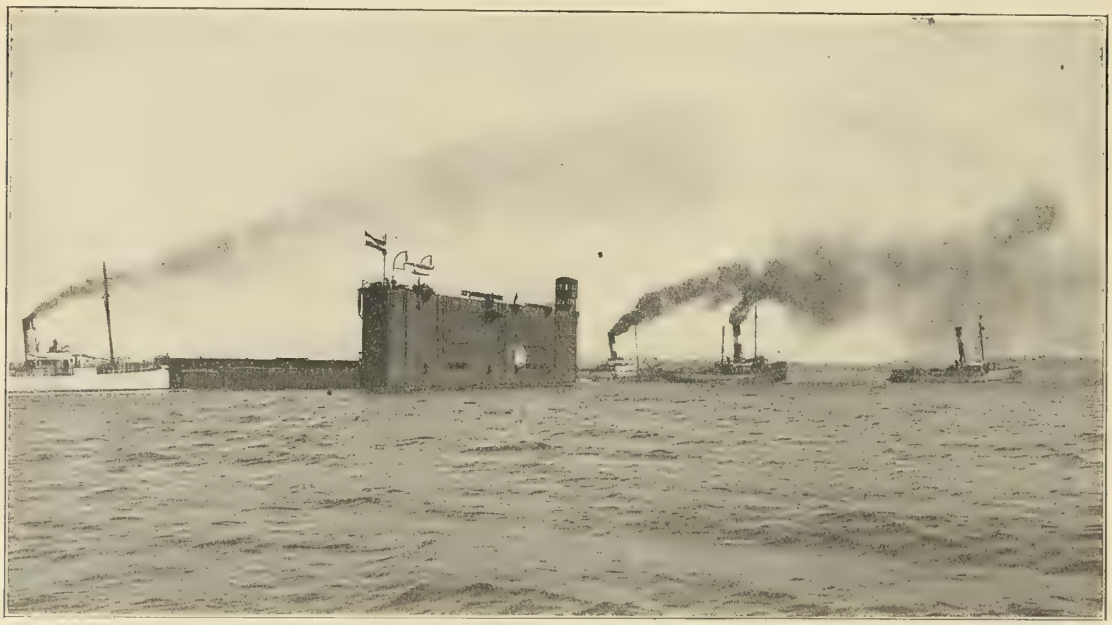
r = mean radius of coil of spring in inches.
d = diameter of wire in coil in inches.
n = number of turns in coil.
P = load on spring in pounds.
P_1 = safe loads in pounds.
E_s = modulus of elasticity for shearing = 11,000,000.
S_e = elastic limit for shearing = 85,000 pounds per square inch.
S_1 = safe shearing load in pounds per square inch.
D = deflection of spring in inches.
D_1 = safe deflection in inches.

The formulæ are for—

Round Steel	*Square Steel*
1. $P = \frac{.196\ S_1 d^3}{r}$	4. $P = \frac{.2 S_1 d^3}{r}$
2. $D = \frac{64\ P r^3 n}{d^4 E_s}$	5. $D = \frac{44.83\ P r^3 n}{d^4 E_s}$
3. $D_1 = \frac{12.56\ S_1 r^3 n}{E_s d}$	6. $D_1 = \frac{8.96\ S_1 r^3 n}{E_s d}$

To show the application of the above formulæ, consider a 3-inch safety valve loaded for a pressure of 160 pounds. The working load on the spring is 1,130 pounds, for which load the spring should be so proportioned that the stress to which the material is subjected is well within the elastic limit, about one-half that amount. The ratio of diameter of wire to mean diameter of coil is, ordinarily, 1 to 5. Calling $S_1 = 45{,}000$, and substituting in equation 4, gives $d = .56$ inch. The spring should have such a number of turns that the compression to give the working load will not be inconveniently great—say about one inch—and that the additional stress put upon the material by raising the valve with the hand gear will not exceed the elastic limit. Determining the number of turns in the coil from equation 5, with D taken as 1 inch, and d as .56 inch, n is found to be 7.78. The maximum deflection of the spring is to be 1 inch plus one-eighth the diameter of the valve—in this case 1 3-8 inches—which, substituted in equation 6, gives $S = 60{,}300$ pounds per square inch, a stress well within the elastic limit, and as such a stress is only occasionally applied it is perfectly safe.

When the valve rises it presents an increased surface to the steam pressure, a circle whose diameter is that of the valve plus twice the breadth of seat, or, with conical seats, twice the projected breadth of face. Assume that the projected breadth is 1-8 inch, then the area under pressure is that of a circle whose diameter is 3 1-4 inches, which would increase the area 1.23 square inches, and the load on the spring would then be 1,130 lbs. + (1.25 × 160) = 1,330 lbs. Then, from equation 5, $D = 1{,}206$, which means that the valve should open .206 inch with a pressure just exceeding 160 pounds; and probably it does when it first rises, but the tendency of the spring to reclose the valve sets up a vibration which continues until, when under a reduced pressure, the valve touches the seat; then it remains seated until the pressure is again sufficiently high to raise the valve. The tendency to increased lift, as the result of the greater surface presented by the opened valve, can be still further increased by turning a lip on the edge of the valve beyond the face and giving the escaping jet a downward direction. The tendency to increased lift when discharging can be defeated, to an extent, by employing too stiff a spring.



TOWING ONE SECTION OF HAMBURG FLOATING DOCK FROM FLENSBURG, GERMANY.

Hamburg Floating Dry-Dock.

In January of last year the Reiherstieg Schiffswerfte und Maschinenfabrik, Hamburg, entrusted to the Flensburger Schiffsbau Gesellschaft, Flensburg, Germany, the building of a large "offshore" floating dock, to the designs of Messrs. Clark and Standfield, of Westminster. The first plate was laid on the keel blocks on the 15th of March, and by the launch of the second half on the 1st of October the dock was practically completed. It consists of two equal sections securely bolted together, having a total length of 507 feet 9 1-2 inches. The breadth is 100 feet 1-2 inch, and the height 41 feet 1-2 inch. With these dimensions a vessel of 11,000 tons dead weight can be lifted; the proposed time for doing this is estimated at about 1 1-2 hours.

The outfit is very complete, comprising all the latest designed improvements for efficient and rapid docking. Besides mechanical bilge and side shores, there are two hydraulic side shores for centering the vessel on the keel blocks. The dock is provided with eight engines, direct coupled by means of rods to an 18-inch centrifugal pumping installation consisting of eight Gwynne pumps. From the main drain, also 18 inches in diame-

ter, there are 32 branches leading to all compartments. Each valve of the pumping compartments is fitted with its own hydraulic press, but certain presses are grouped together and worked by a single lever in the valve house, which is situated on top of the wall. Hydraulic pressure is generated by two accumulators placed upon the respective halves of the dock, whilst steam for the engines is obtained from the shore.

A Worthington pump provides a washing-down service for washing down vessels, as well as filling up their tanks, and a steam service is fitted throughout to protect the inlet and outlet pipes, valves, bilge shores, etc., against frost, and also for heating purposes. Valve indicators, connected to each distributing valve, are fitted in the high wall, and pneumatic water-level indicators for each compartment are placed in the valve house, where they are at all times in full view of the engineer.

The launch of this dock commenced a new era in the history of the Flensburg yard, as it was the first to take place from the commodious new premises opened by the company, where there are five large berths capable of taking vessels of the largest size. The two halves of the dock, which were built side by side, occupied four of these berths. They were towed separately round the Skaw by three strong tugs and arrived in Hamburg after a six days' passage.

MARINE ENGINEERING DESIGN—THE PIPE ARRANGEMENT.

BY J. CALDER.

To the young marine engineer the complicated drawing known as the *pipe plan* and consisting of many superposed lines is not of much educational value. The trees cannot be seen for the forest, and a diagrammatic view with conventional markings will be found more instructive.

On the inset for this month are given the water and steam connections for the triple expansion engine and auxiliary machinery of a modern freight steamer of 1,500 I.H.P. and 10-knot speed. Below in tabular form are the dimensions of the connected apparatus and sizes and service of the various branches for piping. The diagrams are self-explanatory and should be followed in detail, system by system, but the student should bring to their study and analysis a comprehensive idea of the ends to be attained. These are as follows:

Viewed as a heat engine, converting heat into work by the multiple expansion of the working fluid in stages, the primary function of the piping is to convey to the engine a continuous supply of working fluid at a high temperature; to collect in a suitable form by condensation, and in a state free from air or impurities, as much as possible of the expanded fluid, and to complete the cycle of operations by restoring the latter

DIMENSIONS OF PIPES, ETC., IN INCHES.		STEAM EXH.						SUCTION.											DISCHARGE.															
	MACHINERY PARTICULARS.	175	120	30	Cond.	Atmos.	F. W Htr.	M. Boiler.	Aux. Boiler.	Cond.	Sea.	E. R. Bilge.	Bilge Sys.	Ball Sys.	Feed Tank.	F. W. Tank.	Hot Well.	Oil Main.	M. Feed.	Aux. Feed.	M. Bol's.	Aux. Bol's.	Fire Main.	San't. Sys.	Eng. W. Serv.	Cond.	Evap.	Over Board.	Ball Sys.	Feed Tank.	Ash Eject.	Serv. Blow.	Bot. Blow.	F. W. Heater.	Shaft W. S.	Oil Main.
	SPACE, ENG. RM. 25′ 7″. BOILER RM. 23′ 0″.																																	
2	M. Boilers, 14 ft. 0 in. × 12 ft 2 in. × 175 lbs.	5½				7½																										1½	2½			
1	Aux. Boiler, Vertical, 100 lbs.	4				4½																										1½	2			
1	Main Eng's $\frac{22\times36\times59}{42}$	6½			17																															
1	Condenser, 2630 sq. ft										1½					1½																				
1	Attached Aux. Pump, 24½×18									5¾×25																		9		5						
1	Reversing Eng., Direct, 12×16½	¾			1	1	1																													
1	Turning Eng., 6×7		1¼		1¼	1¼	1¼																													
1	Main Feed Pump, VD, 8×5×12	1½			2	2	2								4		4		3	3	2½	2											3		
1	Aux. " " VD, 8×5×12	1⅛			2	2	2	2½	2		4	3½	4		4					3	2½	2	3					3			2½				
1	Ballast Pump, VD, 12×14×12		2½		3	3	3				7		4	10												5		10								
1	Water Serv. & Sanitary Pump, VD, 7×4½×10		1½		2	2	2				4													3	2		⅝								2	
1	Centrifugal Pump, 30 Dia.										10	7													2	9		9								
1	Centrifugal Pump Engine, V, 9×9		2½		3	3	3																													
1	Feed Water Heater, 244 sq. ft					4	4												3																	
1	Evaporator, V, 10 ton		2		3																							3								
1	Ash Ejector, 5																													5						
1	Windlass, 1⅞, 2 Gypsies																																			
1	" Eng., Below, V, Rev., 9×9 Double		2½		3	3	3																													
1	Capstan & Eng. on Deck, Rev., Hor., 6×6 "		1½		2	2	2																													
1	Stearing Eng., Hor., Rev., 7×7 Double.		2		2½	2½	2½																													
2	Winches, Single Gear, Rev. Drum, V, 8×8 D'ble.		2		2½	2½	2½																													
2	Injectors	2																																		
..	Heating System			1¼																																
..	Fire Extinguishers	2																																		
1	Whistle	2																																		
..	Deck Machinery		3		3½	3½	3½																													
..	Auxiliary Machinery in Engine Room		3½		4	4	4																													
1	Hand Deck Pump																																			
2	Cargo Oil Pumps, HD, 12×12×18		2½		3	3	3				10							10										8								10
2	Fuel " " H																																			
1	Generator, 10 K.W.																																			
1	Generator Engine, 6×6		2		2½	2½	2½																													

V = Vertical. VD = Vertical Duplex. H = Horizontal. HS = Horizontal Simplex. HD = Horizontal Duplex.

KEY TO DIAGRAMMATICAL PIPE PLAN SHOWN ON INSET.

in a heat generator to its former temperature. See "main steam circuit" on plan, and compare the course and sizes of the piping from steam outlet back to feed supply on the boilers. It will be noted that to supply an easy access to the air pump for the vapor and non-condensible gases which are mingled with the condensed steam, the passage from the condenser to pump is many times greater than the water volume alone would require.

Owing to practical considerations and limitations, the heat-engine cycle just described cannot be attained with any degree of efficiency without the intervention of auxiliary apparatus of various kinds. The modern marine boiler, particularly the Scotch cylindrical type, does not lend itself to the use of cold feed. Such a practice entails stresses and strains of an excessive character and serious deformation and leakage, owing to the difference of temperature created between the various parts; hence, though theoretically there is no gain, the introduction and practical advantages of preheated feed by placing feed heaters, either of the ordinary or contact type, or sometimes both in series, between the feed pump and the boiler.

The filter tank is also interposed in the return circuit to prevent injurious lubricants caught up by the steam reaching the generator and doing damage there; while of the impurities which reach the boiler or are liberated there, the floating ones, or "scum," are discharged overboard through the surface blow-off, and the precipitated matter is similarly dealt with by the bottom blow.

A small but steady leakage of the operating fluid is always experienced in practical engine working, and this is made up from an evaporator connected at will with the main circuit. The addition is generally made in the form of low-pressure vapor at the low-pressure valve chest, thereby causing the added steam to do some work before condensation.

A rule applying to all marine piping service is that every function of vital importance should be carried out in case of emergencies, such as bilging, leaks, breakdowns, etc., by additional connections to one or even more machines. The regulations of classification and registration societies affecting pipe plans are all directed to securing such safeguards and to preventing, as far as possible, all danger to the vessel by careless or mistaken handling of valves and connections. In one case known to the writer a vessel accidentally bilged was prevented from foundering through the powerful assistance afforded by the bilge suction connections of the centrifugal circulating pumps, while in another the connection was useless at the critical moment, owing to the pumps being designed purely for the light duty of circulating the water through the condenser. At all points in the design of the pipe plan the engineer is preparing for the unexpected.

Make-up feed, for instance, is an absolute necessity, consequently, in addition to the evaporator supply, it is arranged to be drawn, when necessary, from the fresh-water storage tanks—usually under the engine-room floor; while, as a third and last resort, salt-water make-up is introduced from the water circulating through the condenser.

The secondary function of the piping arrangement is to convey the operating fluid to and from the various auxiliaries requiring power, and to afford suction and discharge channels for the many water pipes connected to these auxiliaries through the vessel's skin and to numerous compartments. This section, in a vessel of some size, forms by far the larger portion of the piping outfit and may be divided into two portions, viz.:

1. Auxiliaries and connections required for the propelling machinery.

2. Auxiliaries intended for the safe handling of the vessel, of cargo, and for sanitary and other water services.

In the first class are included: the air pump when independent, detached main and auxiliary condensers, feed pumps (main and donkey), turning engine, reversing engine, independent circulating pumps, evaporator, filter tank, feed heater, engine water service to bearings and for ashes wetting and ejecting, and engine drains and attached piping. Of these, the air, feed, and circulating pumps must be constantly at work in an efficient condition while the vessel is in motion, and the two latter have invariably duplicate services.

The second class embraces: the steering engine, capstan, windlass, deck winches and warping machinery, electric-lighting plant, bilge pumps, ballast pumps, fresh-water and hot-water pumps, sanitary pump, galley pump, deck pump, fire pump and fire mains, distiller, steam extinguisher service, etc. Of the above, the steering engine and bilge pumps have constant duty while the vessel is under way, and care is taken, as will be seen from a study of the chart, to duplicate the sources of steam and water service in as many cases as possible.

Where a vessel is designed for special freight services, such as oil, cattle, provisions, etc., there may be much additional outfit of special pumps and apparatus, which increases the steam demand and the complexity of the piping scheme. In the large twin-screw vessels of high speed, the machinery—which is relatively small in a slow "tramp"—reigns supreme. There the most recent practice is toward disconnected auxiliaries throughout, particularly in warships. The condenser is being made independent and sectional to allow of necessary tube repairs at sea without stoppage of machinery.

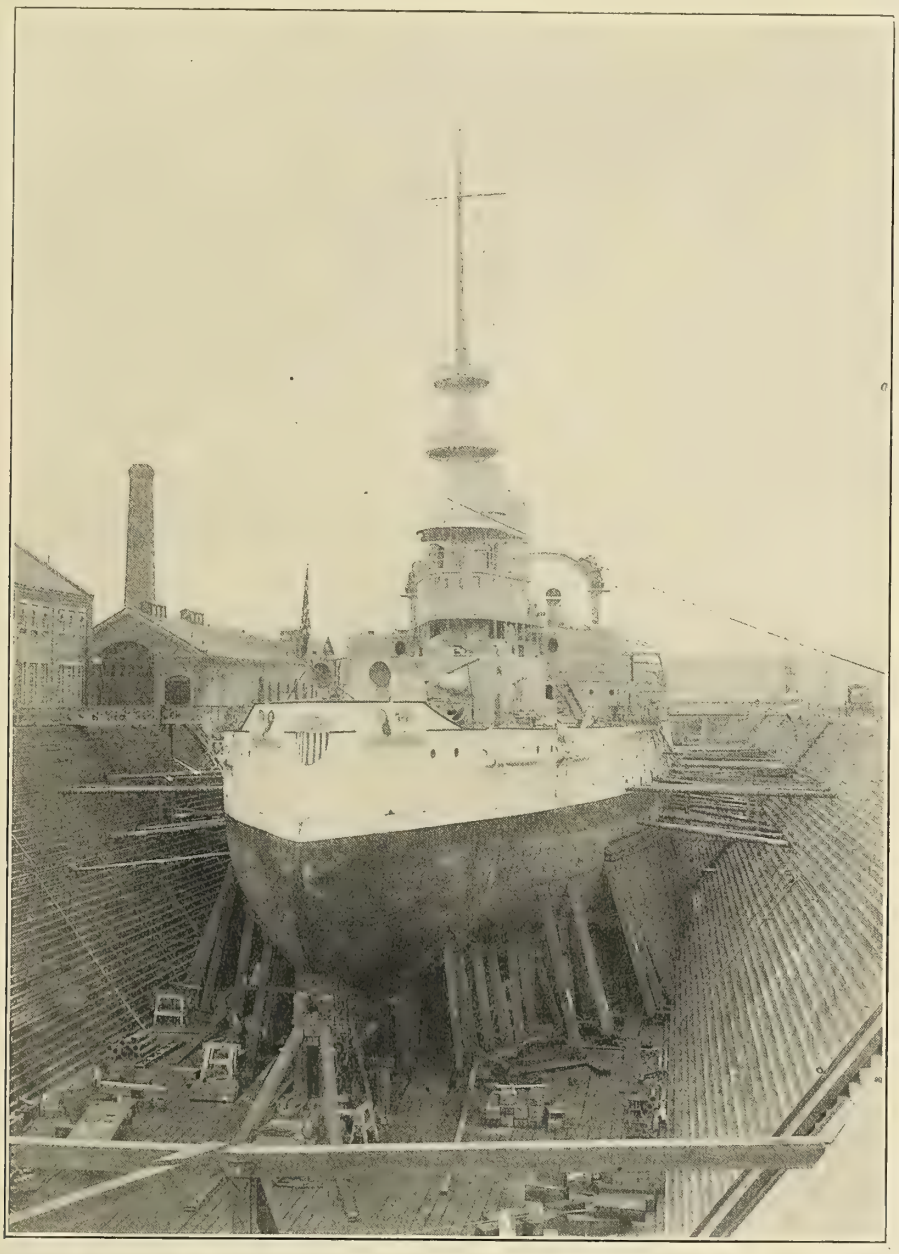
The "backing up" of small engine waste steam to 25 pounds pressure or more, known as the closed exhaust system, entails further extensions of the piping provision for auxiliaries, but at the same time utilizes their steam discharges in doing work (in main engine, evaporator or feed heater) and sensibly affects the fuel bill, which, other things being equal, is, after all, the true mercantile gage of engineering success. Recent progress would indicate that electric-driven deck machinery is practicable, and, in the turbine steamers, several auxiliaries have dispensed with independent steam motors, worm-gearing drives being used from the main engines. There is no prospect, however, of displacing the heavy outfit required for draining and ballasting vessels.

The piping arrangement is, it will be seen, a veritable encyclopedia of the vessel's machinery, equipment, and operation, and will repay close examination and criticism on the part of the marine engineer who desires to have a comprehensive grasp of his profession and duties.

The Battleship Oregon.

As previously described in Marine Engineering, the United States battleship *Oregon* underwent very extensive repairs to her bottom, owing to grounding on an uncharted reef in the Philippines.

In order to get at the damaged plates and frames it was necessary to support a good part of the weight of the hull by shoring carried out near the bilge. The weight of the main turrets was carried by a system of heavy girders erected inside the hull, attached to the side plating, which was supported by the shoring. The accompanying view shows this splendid battleship in dry-dock at the Bremerton Navy Yard, Washington, while undergoing these repairs.



BATTLESHIP OREGON IN DRY-DOCK AT BREMERTON, WASH. SHOWING SPECIAL SHORING FOR REPAIRING BOTTOM PLATING.

THE INFLUENCE OF BILGE KEELS ON THE RESISTANCE AND THE ROLLING OF VESSELS IN STILL WATER.—I.*

BY JOHANN SCHUETTE.

The influence of bilge keels on the rolling of ships has often been the subject of the highest technical consideration, but much more rare has been a discussion of the influence of bilge keels on the resistance to the forward motion of the ship in still water.

Fully a year ago the head of the experimental station of the North German Lloyd at Bremerhaven was commissioned by the German Navy to make experiments in

*Specially translated for Marine Engineering from a paper read before the *Schiffbautechnische Gesellschaft*, Berlin, November 26, 1902.

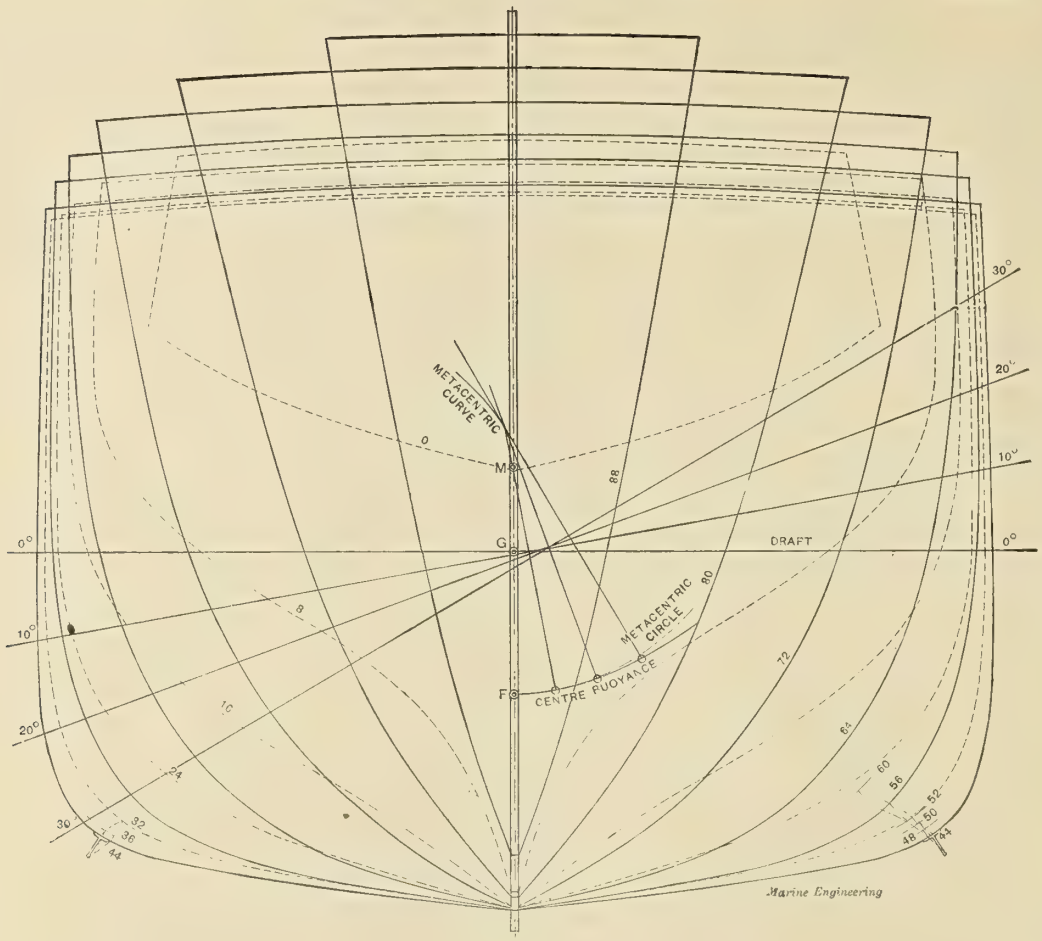


FIG. 1.

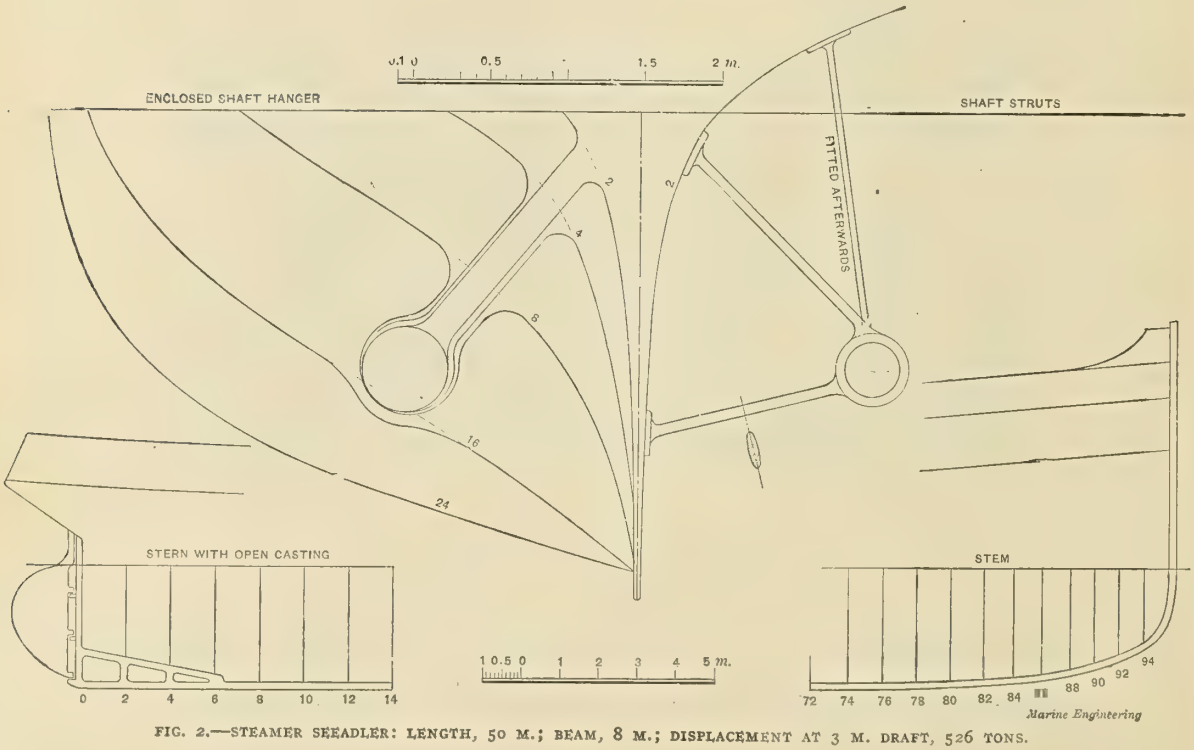


FIG. 2.—STEAMER SEEADLER: LENGTH, 50 M.; BEAM, 8 M.; DISPLACEMENT AT 3 M. DRAFT, 526 TONS.

their tank with a model of a small cruiser, and to determine to what extent the resistance was augmented by the bilge keels. These and several investigations have led to very interesting results, which perhaps will lead to the further question as to how the bilge keel should be placed in order to give the least resistance.

A model to 1-25 scale was made of a small cruiser of the following dimensions:

Length	341 ft. 0 in.
Beam	42 " 8 "
Draft	16 " 5 "
Displacement in salt water, about	5,050 tons.

This was towed through the water at different speeds corresponding to speed of the ship. The effective horse powers were figured from the derived model resistances from the formula:

$$E.H.P_{\text{total}} = .0070356\alpha^3 Vw - .0025887L^{.0875}(O_M - O_S) \times F.V^{2.825}.$$

V = Model Speed in Meters per sec.	Model Resistances in grams.		Difference $b-a$.	Difference in per cent. of a.
	a Without Bilge Keels.	b With Bilge Keels.		
1.029	476	521	45	9.4
1.132	575	630	55	9.5
1.235	685	751	66	9.6
1.338	814	889	75	9.2
1.440	954	1035	81	8.5
1.543	1103	1195	92	8.3
1.646	1261	1378	117	9.2
1.749	1442	1585	143	9.9
1.852	1642	1811	169	10.2
1.955	1871	2045	174	9.2
2.058	2125	2295	170	8.1
2.161	2416	2600	184	7.6
2.264	2825	3073	248	8.7
2.366	3437	3750	313	9.1

COMPARATIVE RESISTANCES OF MODEL WITH AND WITHOUT BILGE KEELS.

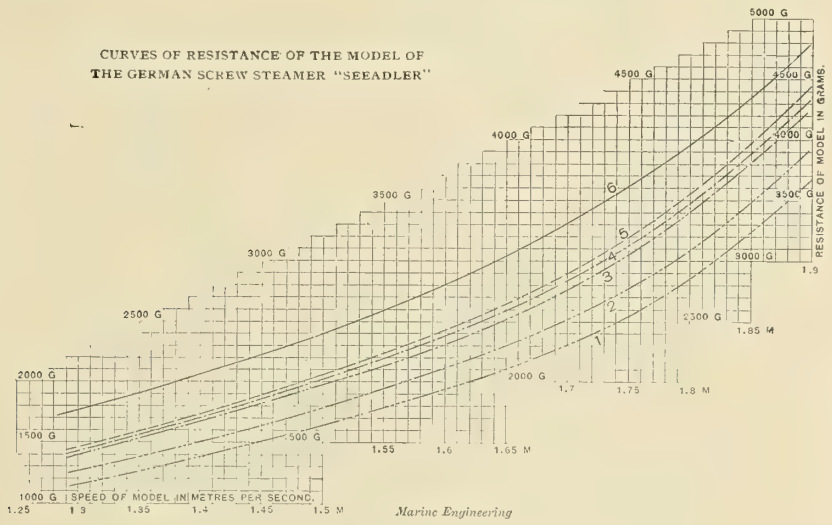


FIG. 3.—SCALE, 1 = 12.5.

This formula was derived from Froude's theory for resistance of ships, which was modified by me through the introduction of the proper constants and read in a paper in the second volume of the transactions of the *Schiffbautechnische Gesellschaft.* In the formula—

α is the relation between the lineal dimensions of the ship and the model.

V the ship's speed in knots.

w the model's resistance in kilograms for the corresponding speed. $V_m = \frac{.5144V}{\sqrt{a}}$.

O_M and O_S constants depending on the relative wetted surface of the model and the ship.

L the water-line length of the ship in meters.

F the wetted surface in square meters.

The following tables give us the resistance of the model firstly without bilge keels, secondly with bilge keels, and the corresponding effective horse powers.

The bilge keels, according to these tables, increase the resistance 9 1-2 to 10 per cent., therefore, from a practical standpoint, if the cruiser travels 50 days in the year at full speed at 22 knots, the increased resistance due to the bilge keel costs $3,750, if we figure .8 kg. coal per H. P. per hour, and coal at $3.50 a ton.

Ship's Speed in Knots.	Effective Horse Power.		Difference $b-a$	In per cent. of a.
	a Without Bilge Keels.	b With Bilge Keels		
10	327	366	39	11.9
11	438	491	53	12.1
12	575	644	69	11.9
13	751	835	84	11.1
14	960	1057	97	10.1
15	1201	1320	119	9.9
16	1477	1643	166	11.2
17	1815	2035	220	12.1
18	2216	2494	278	12.5
19	2704	3001	297	10.9
20	3281	3578	297	9.0
21	3980	4317	337	8.5
22	5008	5511	503	8.0
23	6622	7304	682	10.3

COMPARATIVE RESISTANCES REDUCED TO HORSE POWER.

Although by a change in the arrangement of position and the length of the bilge keel the total resistance may be reduced 4 1-2 per cent., there still remains an increase of 5 per cent. in the total resistance due to the bilge keels, which should cause deep thought to all engineers interested in the economics of vessel propulsion.

According to the newspapers the Americans contemplate building a four-day ocean steamer, which would mean a speed of at least 30 knots. I do not consider the design of such a vessel as involving any technical difficulties, particularly since German ingenuity and industry have evolved a vessel of considerably smaller dimensions having over 40,000 H. P. However, it would be a much more difficult thing to make a vessel of this sort commercially practicable, owing to the first cost and cost of maintenance.

Undoubtedly we Germans have made remarkable progress in the last 20 years in the subject of shipbuilding and marine engineering, and we have arrived at dimensions and speeds which were 20 years ago undreamed of, I do not believe, however, that there will be corresponding progress in the next 20 years unless radical departures are made in the form of vessels and the production of power.

As before mentioned, the model experiments of the small cruiser were the cause of further investigations on the subject of bilge keels. In Figs. 1 and 2 is shown the construction of a tugboat of the N. G. L. of 50 meters length (164 feet), 8 meters (26.24 feet) beam, which has a displacement of 526 cubic meters (which is 532 tons in salt water) at 3 meters (9.84 feet) draft without appendages. The model of this tug, to the scale of 1 to 12.5, was towed at the same draft six times.

1st, with a rudder and without shaft hangers,

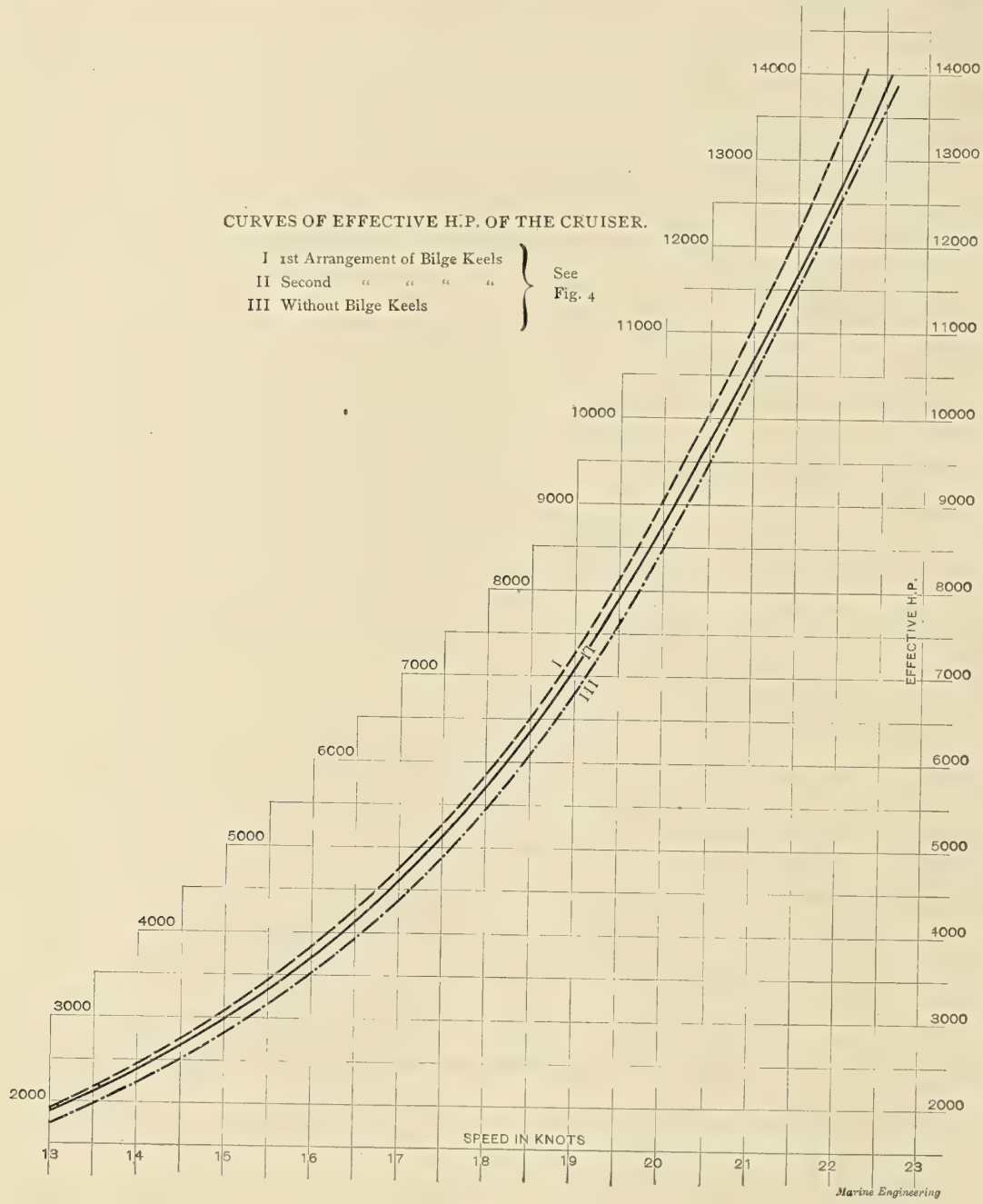


FIG. 5.

2d, with the rudder and encased shaft hanger,

3d, with rudder and shaft hanger,

4th, with the rudder, shaft hanger, and bilge keel,

5th, the same as 4 with the addition of an open, sternpost casting,

6th, the same as 5 with further addition of the screws.

The results of these experiments are shown in Fig. 3 and the following table:

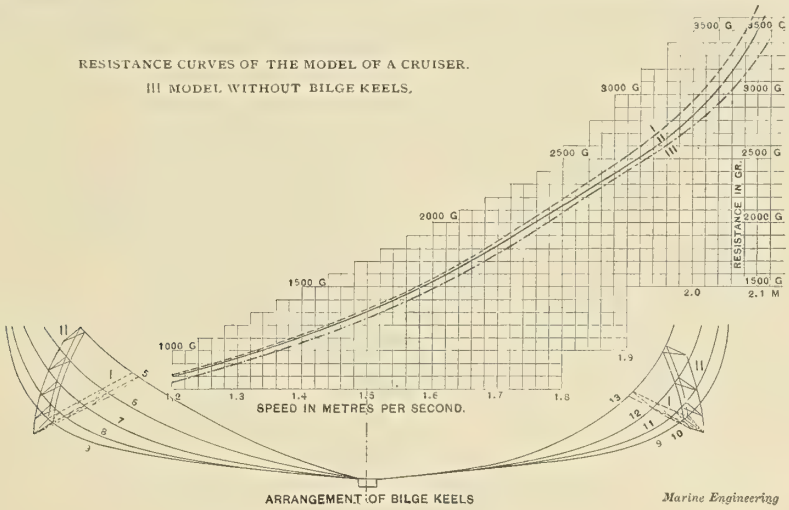


FIG. 4.—SCALE, 1 = 35.

Knots.	1 With Rudder only.	2 With Rudder and Enclosed Shaft Hanger.	3 With Rudder and Struts.	4 With Rudder, Struts, and Bilge Keels	5 With Rudder, Struts, Bilge Keels, and Stern Casting.	6 With Rudder, Struts, Bilge Keels, Stern Casting. and Screws.	Knots.
6	26	30	37	37	38	47	6
7	44	50	58	59	61	76	7
8	68	78	90	91	93	119	8
9	104	115	132	134	138	175	9
10	154	169	196	199	203	247	10
11	219	242	272	280	287	341	11
12	319	354	400	409	420	488	12
13	519	501	618	629	646	706	13
12.61	423	469	517	533	547	613	12.61

RESISTANCES WITH DIFFERENT APPENDAGES.

As the speed of the vessel with 3 meters (9.84 feet) draft and 875 I. H. P. in both engines gave 12.61 knots, we have, through the division of this I. H. P. into E. H. P., the following results:

875 H. P.	1	2	3	4	5	6	875 H. P.
12.61 Kts.	48.3%	53.6%	59.1%	60.9%	62.5%	70%	12 61 Kts.

The coal consumption during the trial trip showed .98 kg. per H. P. (2.16 pounds). If we take 150 days at full speed for this tug, and as we figured coal at $3.50 per ton, we find the cost of this bilge keel from the above table to be $335.00.

This result is much more favorable than that shown on the cruiser. It is explained, however, by the difference in length and position of the bilge keel.

In the small cruiser the bilge keels were 48 per cent. of the vessel's length, while in the tug they were only 33 per cent.; in addition the ends of the bilge keels of the cruiser turned toward the centre, consequently the projection of the bilge keel on the body plan was correspondingly greater than in the tug. The foregoing table teaches us, however, other quantities besides bilge keels influence resistance. If the tug was not fitted with shaft hangers, stern casting, and bilge keel, but with an unencased shaft hanger, unbroken dead wood, and no bilge keel, we would have had with the I. H. P. not 12.61 knots, but 12.95 knots, or, with the same speed, we would have saved 78 E. H. P. or 145 I. H. P. If we, therefore, compare Nos. 2 and 5, we find the cost of the bilge keels, under similar circumstances, figure, as before, $1,790.00 annually in coal. Other experiments, which are represented graphically in Fig. 9, show these conditions did not hurt the sea qualities of the tug, as the swing curves 5 and 9, as shown in this figure, lie very closely together, and the period of a double swing only varies .03 second for the model or 1-10 second for the ship.

In this connection I should like to return once more to the theoretical calculation of ship resistance. Among the fourteen theories of which I am more or less familiar which deal with this subject, it is my belief that the results in the foregoing table of I. H. P. could be figured from none; they are all based, if not on unmeasured, very often on unknown constants, and their calculation is extremely difficult. Distinctions such as the table shows can only be derived from model experiment.

We, therefore, look with great regard upon the action of the German Navy Department, which has, with untold difficulties and cost, instituted an experimental department which will have as its aim, as does the experimental station of the North German Lloyd, the development of vessel forms and propellers. I refer to the experimental station for vessel construction and naval architecture in Berlin.

In Figs. 4 and 8 the further results on the position type and length of bilge keels and their corresponding increase in resistance are shown. The curves in Figs. 4 and 5 show us that although in conformation with the construction of the double-bottom docks, dry-dock gates, etc., etc., it is customary to run the ends of the bilge keels toward the center. It is known, however, that they should be turned to a minimum toward the center, but rather to be turned upward, as the direct resistance is considerably lessened by this means.

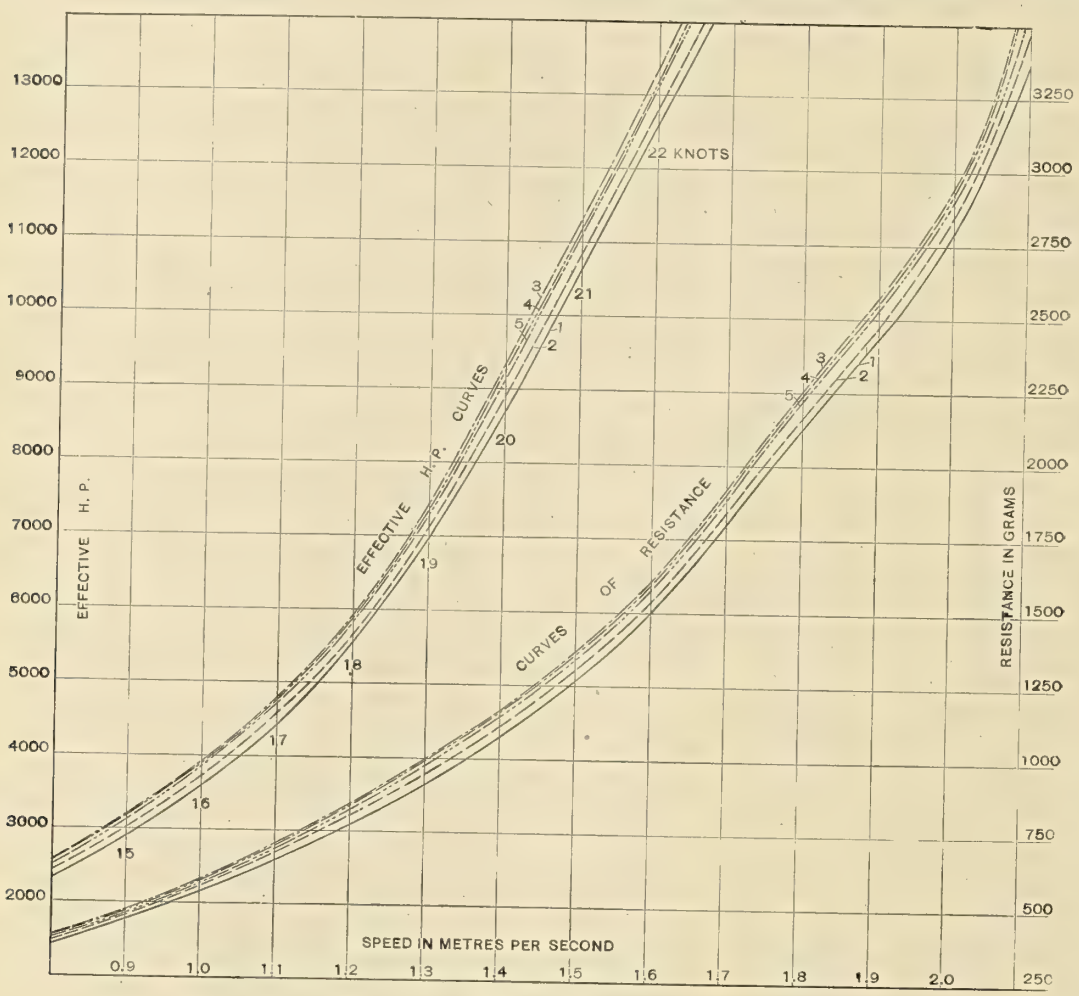


FIG. 6.—LARGE CRUISER. SCALE, 1 = 35. LENGTH, 125 M.; BEAM, 20 M.; DRAFT, 6.89 M.

After the results of the bilge keels resistances, as shown in Figs. 4 and 5, were determined in principle, experiments were made on four models of a larger cruiser, 125 meters (410 feet) in length, 20 meters (65.6 feet) beam, 6.89 meters (22.5 feet) draft. Of these, three were of the same length but of different height, and the fourth, or shortest one, was the result of the experiment. Of this I will speak later.

After investigating these bilge-keel trials and figuring the effective horse power from the model experiments, we find the bilge keels No. 5 on Fig. 6, which are 48 meters long, .6 meter high at centre, and .8 meter high at the end, to be the most efficient. In spite of this the cost of driving a ship, if we assume a large cruiser with 100 full days steaming at 21 knots as a criterion, the increased cost, figuring coal at $5.00 per ton, would be $8,000.00 annually. Similar trials to those with the model tug and the cruiser were made on models of a large transatlantic steamer of high speed, and also on those of a large freighter. These results are given in Figs. 7 and 8. The bilge keels increase the resistance of the liner from 2.8 to 5 per cent.; on the freight steamer only 1.6 to 1.9 per cent., although the bilge keel was 52 1-2 per cent. of the total ship's length. From these figures, figuring the *Kronprinz Wilhelm* as steaming 105 full days at 23 knots, we find an annual cost of $9,120 due to the bilge keels, with coal at $3.50 per ton, while for the freighter, with 200 days full steaming at 13 knots, the increase will be only $775.00. All the trials here mentioned on bilge keels depend, of course, on smoothly-built bilge keels running even with the strakes. The accompanying Fig. 10 shows the sections of the different keels.

It is assumed in all these cases that bilge keels will be used, in spite of the increased cost and the eventual damage to the boat, on small ships with fine form, that is to say, by small ships in which the first consideration is high speed. These bilge keels, however, should not be over .3 the length on small boats and .38 on the large ones, and the ends should be run at such course that the

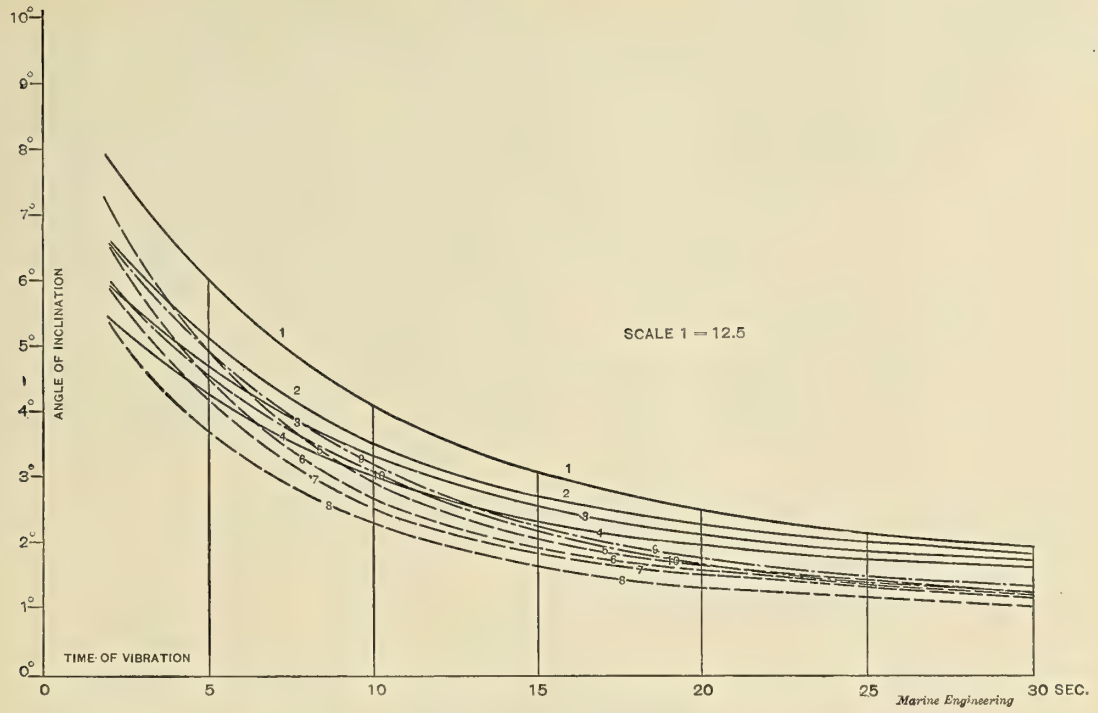


FIG. 9.—STEAMER SEEADLER.

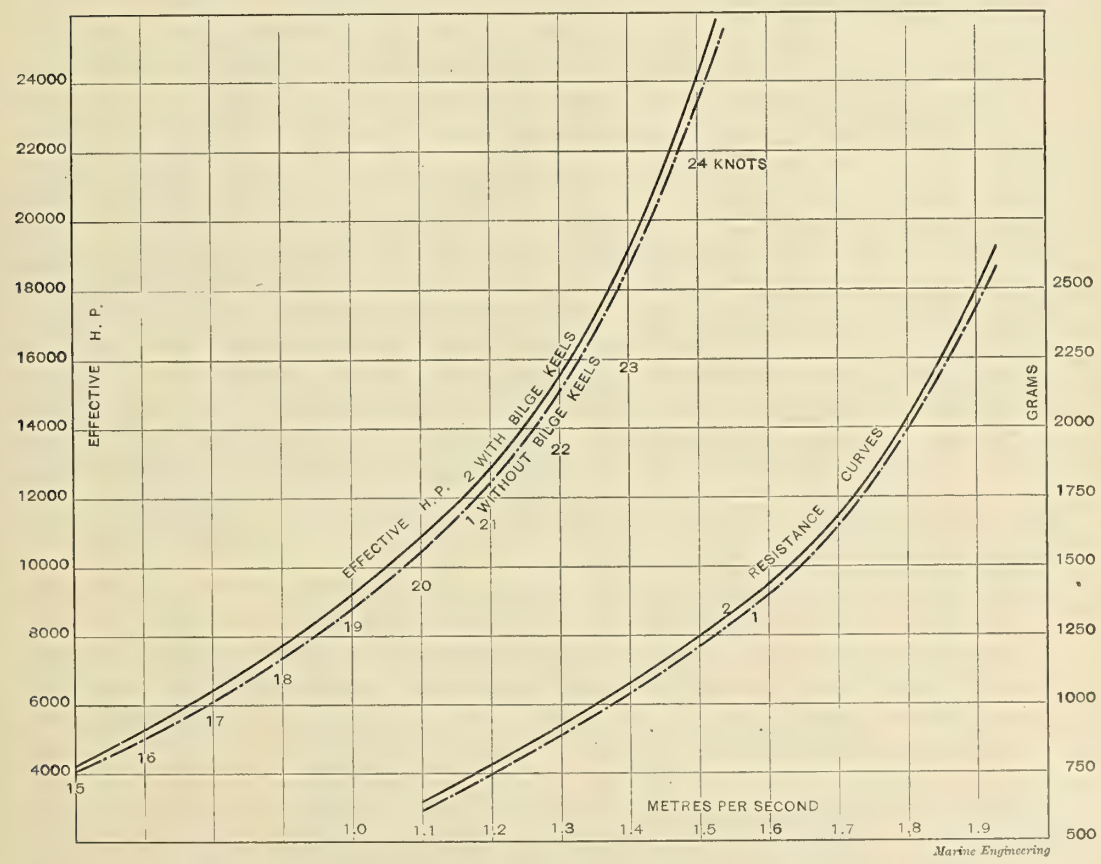


FIG. 7.—STEAMSHIP KRONPRINZ WILHELM. SCALE, 1 = 45. LENGTH PERPENDICULARS, 193.54 M.; BEAM, 20.10 M.; DRAFT, 8.185 M.

With Encased Shafts, Displacement 19,625 tons; Wetted Surface 5,190 sq. m.

With Encased Shafts and Bilge Keels, Displacement 19,634 tons; Wetted Surface 5,270 sq. m.

projection of the bilge-keel surfaces shall be a minimum on the longitudinal section of the boat.

This last question will often necessitate a drawing up of the bilge keels, particularly at the stern of the vessel.

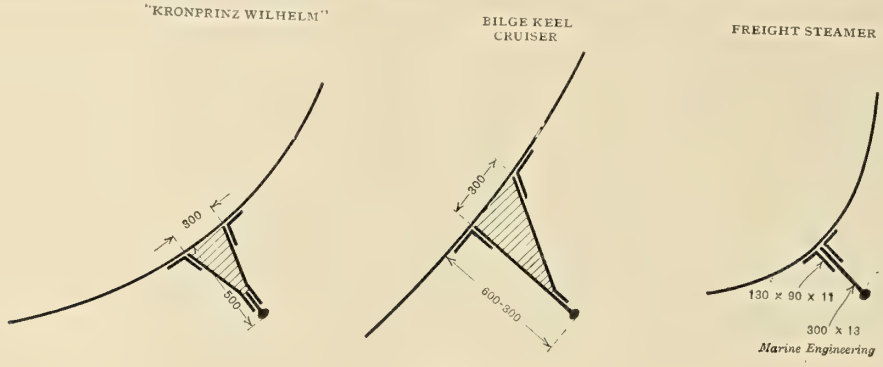


FIG. 10.

On large freight steamers with long, dead-flat midship portion, without particularly increasing cost of operation, the bilge keels can be carried for full half length amidships.

The question of whether bilge keels should be used or not can only be determined, from my point of view, if we compare their effect on the rolling of the ship together with the increased cost which is due to the increased resistance of the vessel.

Without doubt the uses of the bilge keels are many, and should be recommended in spite of the increased cost for vessels of war, where the effect of rolling is such that the efficiency of the gunfire is seriously impaired, where an increased efficiency in that respect is greatly desired; and even in merchant vessels the bilge keel should not be looked upon merely as fashion.

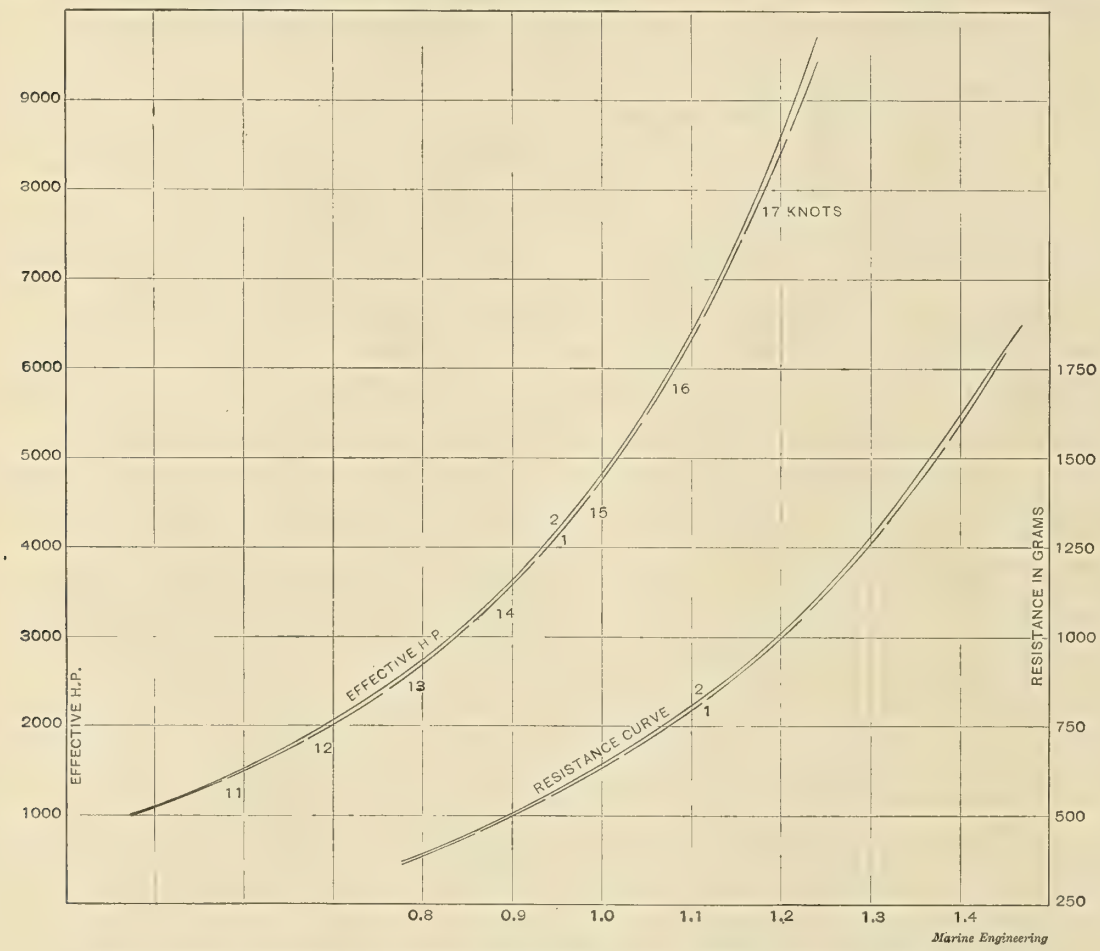


FIG. 8.—FREIGHT STEAMER WITH ENCASED SHAFTS, SCALE 1 = 40. LENGTH, 151.72 M.; BEAM, 18.3 M.; DRAFT, 8.966 M.; BILGE KEELS, 79.8 M. LONG.

Without Bilge Keels, Displacement 18,535 tons; Wetted Surface, 4,543 sq. m.
With " " " 18,540 " " " 4,607 " "

LAUNCHING THE TIEMONTE ON THE GULF OF SPEZIA.

LAUNCHES.

Picturesque Launching.

The accompanying photographs are of vessels launched from the picturesque yard of Mugdiano, on the Gulf of Spezia, on the Ligurian coast of Italy. It would appear that, owing to the proximity of the hills, there was not room for a large yard to be established at this point and that the output would be small. Our correspondent, however, advises us that the yard

LAUNCH OF THE PRINCIPENA LACTITIA.

covers nearly 580 acres. It is located behind the Crandrella Point, is protected from the south winds by a breakwater built across the mouth of the gulf. The bay also has the advantage of being protected by fortifications, so that the yard would be of great service in time of war. The output since the year 1898, when the yard was established, has been increasing, and in 1900 five vessels were launched of nearly 20,000 net tons. In 1901 four ocean steamers were launched, one, the *Tiemonte,* belonging to the Luigi Capuccio Company, being the largest cargo boat in the foreign merchant marine. The vessel is of steel, awning-deck type, 390 feet long over all, with a carrying capacity of 7,800 net tons on 24 feet draft. During the last year five large ships were launched from this yard, including the *Principena Lactitia,* of which a description is herewith given, and three small ones. There are six building ways, varying from 340 to 560 feet in length.

The *Principena Lactitia,* the last vessel to be launched, belongs to the Luigi Capuccio Company, of Corino, and is of the following dimensions:

NAME—Principena Lactitia. NATIONALITY—Italian. BUILDER—Mugdiano.
TYPE—Ocean Freighter. LAUNCHED—1902. OWNER—Luigi Capuccio Co.

Length over all	339 ft.
Between perps.	324 "
Beam	48 "
Depth	25 " 3 ins.
Load draft	21 " 6 "
Load displacement	
Gross tonnage	7,564 tons
Engines, type	5,200 "
I. H. P.	three-cylinder, triple-expansion
Cylinder diam	2,100
Stroke	24, 40, 66 ins.
Revolutions on trial	48 "
" in service	85
Steam pressure	76
Valves	160 lbs.
	Piston for H. P.; slide valves for M. P. and L. P.
Framing	Cast-iron columns
Bed plate	Cast iron
Condens. surf.	2,605 sq. ft.
Shafting, crank	13 3-8 ins.
" line	12 7-8 "
" propeller	14 1-4 "
Propeller, type	four blades
Diameter	16 ft. 6 ins.
Pitch, variable	17 " 6 " to 17 ft.
Projected area	82 sq. ft.
Boilers, number	2
Type	single-end Scotch
Length	11 ft. 6 ins.
Diameter	14 " 9 "
Number of furnaces in each	3
Inside diam. of furnaces	44 ins.
Length of grates	5 ft. 3 1-2 "
G. S. total	112 sq. ft.
H. S. "	4,418 " "
Tubes, number in each	381
" diameter	2 1-2 ins.
Tubes, length	7 ft. 9 "
Howden draft	
Speed, full load	10 1-2 knots
H. S. ÷ G. S.	39.44
H. S. ÷ I. H. P.	2.10
I. H. P. ÷ G. S.	18.75

Steamer Tionesta.—The steamer *Tionesta,* recently launched for the Erie and Western Transportation Company from the Wyandotte works of the Detroit Shipbuilding Company, is a practically new type of vessel for the Great Lakes. She is designed for the passenger service of the Anchor Line between Buffalo and Duluth, and will also be a large package freight carrier. She is what on the coast might be termed of the "intermediate" type. The Anchor Line has several smaller vessels of this class, but the *Tionesta* is the forerunner of the large passenger and freight steamer. The principal dimensions are: length over all, 360 feet; keel, 340 feet; beam, 45 feet; depth, 28 feet. Her double water bottom, extending throughout, is of 900 tons capacity, while the cargo capacity is 3,500 tons and the coal bunkers 350 tons (all net tons). There are accommodations on the upper promenade deck for 350 passengers. Four lines of state rooms extend from the forward bulkhead to the stack, and on the promenade deck amidships is the

dining saloon, with a seating capacity of 136 passengers, and other large state rooms. The vessel is propelled by a quadruple-expansion engine with cylinders 22, 31 1-2, 45, and 65 inches diameter, with a common stroke of 42 inches. This engine when running at 100 revolutions per minute is designed to indicate about 2,500 horse power. Steam is supplied at 210 pounds pressure by three cylindrical boilers 12 feet 6 inches in diameter by 11 feet 3 inches long, equipped with forced draft.

Six-Masted Schooner.—There was recently launched from the yard of Percy and Small, Bath, Me., the six-masted schooner *Addie M. Lawrence,* 292 feet long, 48.3 feet broad, 22.2 feet deep, with a gross tonnage of 2,807. This firm built the *Eleanor F. Percy.*

Steamship Minnesota.—The ship *Minnesota,* built by the New York Shipbuilding Company for the Atlantic Transport Company, was launched on December 15. The vessel is 490 feet in length over all, 58 feet extreme molded breadth, 27 feet depth of hold. She will have a carrying capacity of 10,000 tons and will be fitted for carrying 900 head of cattle.

Fishery Protection Steamer.—The oaken steamer *Kestrel* is nearing completion at the yard of Mr. A. Wallace, Vancouver, B. C., and is to be used by the Canadian government in policing the northern fishing waters. The vessel is 145 feet long over all, 24 feet beam, and 13 1-2 feet deep. She has a compound engine with cylinders 18 and 38 inches by 24 inches, which drive the vessel at a maximum speed of 12 knots. She is to carry a crew of fifteen men besides her officers. The accommodations are very handsomely finished in quartered oak.

Steamer John B. Cowle.—On October 2 the steamer *John B. Cowle* was successfully launched from the plant of the Jenks Shipbuilding Company, Port Huron, Mich. The new vessel is built for W. W. Brown and others, of Cleveland, and is a sister ship to the *Henry Steinbrenner,* recently launched at the Jenks yard. The dimensions of the new boat are: Length over all, 440 feet; on keel, 420 feet; beam, 50 feet; depth, 28 feet. The engine is triple expansion with 23, 37, and 63-inch cylinders, all of 42 inches stroke. Steam is supplied at 185 pounds pressure by three Scotch boilers 12 1-2 by 12 feet.

Oil-Tank Steamer.—The oil-tank steamer *Spondilus,* launched from the yard of William Gray and Company, has been added to the petroleum-carrying fleet of the Shell Transport and Trading Company, Ltd., London. The dimensions of the *Spondilus,* which is a sister ship to the *Pectan,* are: length over all, 483 feet; beam, 55 feet; depth, 34 feet 10 inches. The water bottom is fitted the entire length of the vessel. The engines and boilers are placed aft and the cargo space is divided by thirteen transverse and one fore-and-aft bulkheads from the keel to the main deck. The holds are so constructed that the vessel may be used for general cargo, if desired. The triple-expansion engine has cylinders 29 1-2, 48, and 78 inches diameter by 54 inches stroke. The six single-end boilers are fitted for burning oil on the Flannery-Boyd system with Rusden and Eeles burners.

SCHOOLS FOR MARINE ENGINEERING AND NAVAL ARCHITECTURE.

The Naval Architecture Department of the Durham College of Science, Newcastle-upon-Tyne, England.

BY GEORGE CROUSE COOK.

In the month of October, 1871, the University of Durham and the North of England Institute of Mining and Mechanical Engineers jointly established the Durham College of Science, at Newcastle-upon-Tyne, England, by the reorganization of the old school, which was specifically known as the University of Durham College of Physical Science.

The support of the college is to a certain extent gained from voluntary contributions, and these subscribers or their representatives compose the registered incorporated society which, in the terms of the constitution, stands for the college. These subscribers, among whom are the prominent shipbuilders and engineers of the district, are called governors, and the actual executive of the college is held by a council consisting of certain officers of the university and college, together with certain governors elected from and by this body. The present staff of instructors consists of twelve head professors, together with some fifty assistant professors and lecturers and an independent staff of examiners who are drawn from the different colleges and universities of England.

The grounds occupied by the college are well situated some three-fourths of a mile from the center of the city of Newcastle, and are of some six acres in extent; this includes, in addition to the building ground, a botanical garden, plots for the demonstrations of the agricultural department, and several tennis courts. The main building of the college is a broad, rectangular block built up about the quadrangle. The most prominent feature, one of which all Newcastle is proud, is the central gateway tower, which was erected as a memorial of the Royal Jubilee of 1887. In addition to this main building is the picture gallery of the Newcastle Exhibition of '87, which was taken down and re-erected on its present site for the work of certain of the departments and to give accommodations at the college for the men students.

There are at present well-developed courses in mathematics, engineering, mining, naval architecture, classic and modern languages, education and art, as well as the specific work of the natural sciences. Regular students in these courses who have followed the lectures and classes for two sessions may enter an examination for the University title of A.Sc.—that is, Associate of Science—and these associates, after the third session work, become candidates for the full degree of Bachelor. In addition, the college confers the advanced degrees of Master and Doctor after certain requirements in original professional work have been fulfilled. Certificates of efficiency are granted to students not entering the regular degree course, but who attend the lectures and qualify in the class examinations for certain specific work in the courses of agriculture, engineering, or mining. Students entering the regular courses with the object of gaining the degree are

termed matriculated, and must qualify in an entrance examination or present certificates of equivalent proficiency. Non-matriculated students, or those taking up special studies only, as naval architecture or engineering, are not required to pass entrance examination, while they have quite the same general privileges as the former class.

The study of naval architecture is, as usual, a part of the three-years engineering course for the degree in science. This course, as a whole, embraces the following work: First year—mathematics, theoretical and practical physics and chemistry. Second year—applied mechanics, engineering practice, physics or chemistry, and naval architecture with drawing. Third year—advanced engineering, chemistry or physics, naval architecture and drawing. The general work of the course follows the usual lines, with the exception that particular stress is laid upon the practical development of each subject, and to this end the laboratories of the college are as complete and well equipped as the best in England. The study of naval architecture, which first appears in the second year of the course, begins with Junior class work requiring an attendance of six hours per week, and embraces the leading topics of construction, laying off, calculations and drawing. The Senior class—that is, the class of the third year—continues the work of the previous, and with an attendance of six hours per week, embraces the leading topics of practical construction, laying off, advanced calculations, propulsion of ships, and advanced drawing. For the subject of steam propulsion the students in naval architecture enter the regular class in marine engineering.

The lectures of the Junior class relate to various details under the principal topics, as follows: Construction—detail of transverse and longitudinal stiffening; properties of the different shipbuilding materials; riveting, templating, working, and erecting; preparation of working plans—*i. e.*, plans of the midship section; forgings, keel and keelsons, bulkheads, decks, shell plating, etc. Laying off—explanation of sheer draft; fairing; expansion of cant frames, stern plating, shell plating, and masts; preparation of scrieve board. Calculations—areas, volumes, weights, etc., of various bodies; areas of curved-line planes by the different rules; principles of displacement and flotation; volumes, centers, and coefficients of varying displacements; areas, centers, and coefficients of midship sections; areas, centers, and moments of inertia of water planes; tons per inch and variation of draft in salt and fresh water; initial stability and metacentric diagrams; weights of materials. The drawing of this year follows the lines of the lectures and consists of the drafting of various details of construction and working plans, together with the calculation and plotting of the different curves of form, as displacement, tons per inch, coefficients of sections, etc.

The lectures of the Senior class carry on similar work under the respective leading topics, which may be detailed as follows. Practical construction—systems of ship construction and details; methods of erecting; relative merits of wood, iron, and steel; efficiency of riveted laps and butts; details of structures and relative thickness of plates. Laying off—drafting of 3-4-inch lines; fairing on loft floor; expansion of involved forms as poop round, turtle back, etc. Calculations—the areas, volumes, etc., of complex figures; proofs of the various rules for plane areas, with methods of application in specific cases; curves of displacement, tons per inch, section area, wetted surface, etc.; centers of buoyancy, flotation, and gravity; moments of inertia and metacentric stability by approximate and accurate methods; curves of statical stability; effect of dimensions on curve; effect of stability of bilging, shifting cargo, coal consumption, etc.; cross curves of stability; experimental center of gravity; calculations for trim, moment to alter trim by various methods, with proofs; alteration of trim due to shifting of weights; dynamical stability; Moseley's formula; relation between statical and dynamical stability; oscillations of ships; properties and formation of waves; strength of ships; the curves of loads, sheering force, and bending moment;

COLLEGE OF PHYSICAL SCIENCE, DURHAM UNIVERSITY.

parts of structure resisting stresses; neutral axis, equivalent girder; local and structural strength; tonnage, deadweight and freeboard measurements. The Senior class drawing begins with the preparation of the plans and material order for a cargo steamer. These plans are developed for a merchant steamer of a given type, to carry a specific weight of cargo and coal on a given draft at a certain speed. The method followed is to first approximate the displacement, dimensions, freeboard, and tonnage, and then rough out the lines for the horse power and weight calculations. This work may show errors in details, which are corrected and the lines faired and plans completed. When this part of the design is finished, investigation is made of the conditions of stability, etc., as far as the time of the session and the industry of the student will permit.

The classes in engineering treat the subjects of mechanics, hydrostatics, steam, the steam engine, machine design, and propulsion of ships. The advanced engineering of the third year, which should be followed by the student of naval architecture, has special relation to the marine engine and boiler, and consists in detail of the following: Marine Boilers—the determination of dimensions of boilers under different conditions of working pressure, type, and steam expansion; the

weights of boilers, and insurance rules governing the design. Marine Engines—the determination of dimensions of engines for the conditions of economy, space occupied, and weight; piston speeds and revolutions; relation between revolutions, mean pressure, and horse power developed. Propellers—the dimensions of propellers to fulfill given conditions, efficiency of various types; effect of diameter, pitch, and surface. Propulsion of Ships—water resistance to motion; influence of form and dimensions on the resistance. Methods of estimating power and speed; Admiralty coefficient; augmented surface method; Kirk's analysis; law of corresponding speed and its practical application; speed trials; progressive runs; recording speed and power curves; application of these results to different types in practice.

For students not able or desirous of taking up this complete degree course, an excellent modification stands in the "certificate of proficiency" work, which consists of attendance at certain of the regular classes in mathematics, physics, and engineering, together with the Senior and Junior courses in theoretical naval architecture and drawing. This work may be carried out over a period of two or three years, and is one which would be particularly suited to foreign students needing the mathematical training necessary to follow intelligently the advanced theoretical work of naval architecture, but who had no particular interest in the complete course required for the degree. During the summer vacation of two and one-half months, and the Christmas and Easter holidays, the Durham student has exceptional privileges for entering the neighboring shipyards, which are usually closed to strangers, and by careful observation he may learn the advanced and economical methods of working for which the builders on the Tyne are noted.

Evening classes have been established in all of the departments to carry on the broad and liberal idea of the foundation of the college, which was to offer instruction to all persons. The students of these classes have the same college standing and divisions as the day students, and are also eligible to the titles and degrees of the university. The arrangements are such that the student who has qualified in an entrance examination and performed the work of the class during a period of four years is qualified to take the final degree examinations. In a similar manner the work of the "certificate of proficiency" course is carried on, and simple attendance at the classes is allowed on payment of the fees. This offers a splendid opportunity to the working draftsman or shipbuilder of the neighborhood to acquire a degree, certificate, or the general class knowledge of his subject.

The cost of a year's attendance—that is, from the middle of September to the end of the following June—in these two naval architecture classes can be approximated as follows: Board and lodging at the "Hostle," which is the officially recognized residence for men students, can be had for $260 per school year, while the college fees for matriculation, naval architecture lectures, and drawing could be covered by $60. In addition to this would come traveling expenses to and from Newcastle, and incidentals for books, instruments, local excursions, etc., which are practically within control. The cost of living could also be more closely brought in hand by taking up an independent residence outside the college on the conventional English lodging system.

FIGUREHEAD FROM THE FRANKLIN.

The Passing of the Figurehead.

It is a great exception nowadays to find on the bow of the steamship entering our port the time-honored emblem—the figurehead; in fact, this is but rarely seen even on sailing vessels, and the ship carver's trade is kept alive solely by yacht owners. Years ago, and even back to the time of the earliest ships, the figurehead was considered a necessary part of the vessel, and as much attention was paid to its design as to any other part of the hull. Illustrations of the Roman galleys show clearly what a prominent part this feature of the design held, and later, in the days of the Norsemen, figureheads at the prows of their vessels represented goddesses who were supposed to lead them into victory. On merchant ships it was looked upon as a genius to protect the vessel from storms and disasters.

Up to within a very few years no sailing vessels and but few steamers were without a figurehead, and, where the name of the vessel permitted, this piece of carving was emblematic of the ship's name. Thus the fine old *City of Rome* has under its bowsprit a figure of Julius Cæsar, and the old steamer *Expounder* had a figure of John Marshall holding a copy of the outspread Constitution. The American eagle was always very popular as a figurehead, and it is even now often seen on steamers, not placed at the bow, however, but on the pilot house. The most popular subject, however, was some female figure. Possibly it may be this fact which has caused the gender of a ship generally to be considered as feminine.

The Italians are famous for the bow and stern decorations of their vessels, and the intricacies of the design are no less wonderful than the colors displayed.

In the days of our famous frigates, much attention was given to the figurehead. At the bow of the old *Constitution* was placed a splendid colossal statue of Andrew Jackson. This figurehead and that of the U. S. S. *Franklin* are now preserved at the Annapolis Naval Academy, and, although these carvings were exe-

cuted fifty or seventy-five years ago and have weathered countless storms, they are still almost perfect. The *Constitution* was launched in 1797, and, according to Soley's history of the Naval Academy, the head of this statue was sawed off and made away with in 1834, and the head which is now preserved was put on the following year. The U. S. S. *Franklin* was launched in 1815. The figurehead bears the painted date, 1853, which was the date when the *Franklin* was razed at the Portsmouth Navy Yard.

It is pleasant to note that the Navy Department is reviving this custom of decorating the bow and stern of our warships. On most of the new vessels a shield and scroll has been placed at the bows, but at present this work is being carried on to a greater extent, and on such vessels as the *Olympia, Cincinnati,* and *Massachusetts* are found very handsome pieces of bronze. The decorations of the *Olympia* and *Cincinnati* have already been described in Marine Engineering.* On the forward turret of the battleship *Massachusetts,* between the two 12-inch guns, is placed a bronze statue of Victory, which was presented to the vessel by the State of Massachusetts.

FIGUREHEAD OF THE STEAM YACHT DREAMER.

However, as above mentioned, it is to the yacht squadrons that one must turn to find the greatest number of figureheads. The one here illustrated is on the steam yacht *Dreamer.* At the stem the body of the figurehead is divided and the design carried along the bulwarks on either side by a well-worked-out scroll. Among the merchant steamers the bowsprit has been entirely done away with, which is doubtless the cause of the disappearance of this ancient emblem.

It is of interest to note that a collection of old figureheads is becoming quite a fad with certain people.

*See Marine Engineering for December, 1901, and April, 1902.

THE CONSTRUCTION OF MOTOR LAUNCHES.

BY W. F. DURAND.

Within the brief limits of a single chapter only a few general hints can be given regarding the construction of motor boats. While principles are eternal, practice is continually varying, and many of the details of construction will naturally depend on the materials at hand, the skill of the builder, the particular purpose in view, and other special circumstances of the case.

Let us first endeavor to realize clearly the purpose which the builder must constantly hold in view. This purpose, which is twofold, may be stated as the realization of form and the provision of the necessary strength. The first has reference to geometry, the second to mechanics. The design has furnished a form which is to be realized in the actual materials of construction, and with such a distribution of material as shall provide at the same time the needful strength and rigidity of structure. In addition to form and strength, some part of the work of construction will have reference to matters of internal fitting and equipment; matters which relate simply to questions of taste and convenience. These latter are so entirely dependent on taste, and may vary so widely with the special purpose in view, that they may be passed over with the mere mention, and with this understanding we may proceed with the development of our subject under the two heads as noted above.

FORM AND STRENGTH.

While the purpose of the builder is thus twofold, it must by no means be supposed that of the various structural members employed some are used solely for strength and others for form. It is one of the highest purposes of the builder to so arrange his material that, so far as possible, each member may serve a double

purpose; that it may take its part in determining the graceful form and contour of the boat, and at the same time add its quota to the needful strength. While the aim of the builder is thus to use his material for a double purpose, it will be preferable to consider here the two aspects somewhat separately.

In the first place it may be noted that the actual form is determined by the outer skin or planking. This, however, cannot be realized, the planks cannot be put into shape, without something within over which they may be bent and formed as desired. Even after they are brought into shape, thus forming a hollow shell, they would of themselves scarcely retain their form without some permanent internal framework or stiffening to counteract their own tendency to spring away from the form to which they were adjusted. We have thus begun with the skin because, in a sense, this is the boat itself. All else is secondary and auxiliary. We have seen, therefore, that in order to realize the form something must be provided over which the strips of planking may be bent as required, while to retain it in form something must be provided in the way of internal stiffening and tying members. Now, it is just here that we find two different methods in boat construction. In one, which is quite commonly employed with pulling boats and to a considerable extent in the construction

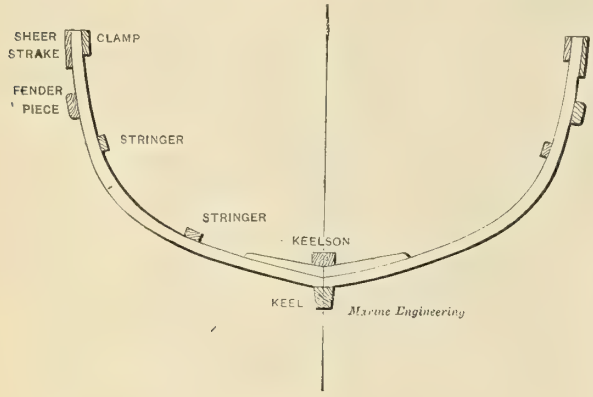


FIG. 1.

of small and moderate-sized motor boats, the forms over which the planking is bent are simply wooden molds put in place temporarily, their sole purpose being to determine the form of the boat. In the second type of construction, which is always used for the larger sizes, the frames and cross ties or deck beams are formed and set up first and the form of the boat is thus determined in skeleton. The planking is then bent to form over the frames and secured to them. In this case, therefore, the forms over which the planking is bent to shape constitute a permanent part of the structure.

We have above referred to the transverse framing as intended to give stiffness and permanency to the form, and such is, indeed, the case, but not alone against the natural tendency of the skin to spring or bend into some other form. It is here that the question of *strength* comes in. Permanency of form and durability of service require sufficient strength to withstand the external forces for which provision should be made, and we are thus led to the second main object of the builder. The skin of the boat, together with a suitable amount of transverse framing to give it permanency, constitute the determination of form, and thus represent the realization of the first main object. At the same time these members go a long way toward giving the needful strength. In fact, the necessity of fitting the spring of the frame against the spring of the planking usually gives sufficient strength in the transverse direction, so that aside from skin and framing the added members are almost entirely those which are needed to complete the necessary longitudinal strength. Without developing this part of the subject from the standpoint of mechanics, it will be sufficient to note that this end is attained by fitting some combination of keel, keelson, sheer strakes, deck and side stringers, clamps, and fender piece. These various members are shown in Fig. 1, though but rarely would they all be found in one design.

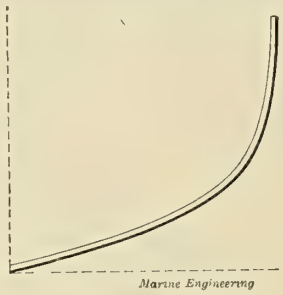


FIG. 2.

To sum up this part of our subject, it appears that form is determined in general by the skin planking together with the transverse framing: transverse strength is provided by the combination of skin planking and transverse framing; longitudinal strength is provided by the combination of the skin planking with the various longitudinal members noted above. Otherwise we note that the skin takes part in the determination of form and in both the transverse and longitudinal strength; the transverse framing takes part in the determination and preservation of form, and in the transverse strength; the various longitudinal members above noted have but slight direct relation to form, and their chief function is to act with the skin in furnishing longitudinal strength. Having thus examined the subject in a general way, and from the standpoint of the functions which the various parts perform, we may consider briefly the principal steps in carrying out the construction along the lines indicated.

LAYING DOWN THE LINES.

The first step in the process of construction is to lay down the lines of the boat, the water lines and sections corresponding to frames and molds, full size on the floor or mold loft. These lines are laid down from the design and are faired up in the same general manner as described in the chapter on design. This gives everything full size and makes possible the ready determination of the dimensions and form of any part of the boat as may be needed.

Reference should be made at this point to the fact that lines as usually laid down relate to the form or the outside of the frames or on the inside of the skin. In such case the lines are immediately available for use in determining the form of molds, frames, etc. In

some cases, however, lines have been laid down representing the outside of the planking, the actual outer surface of the boat. In such case, after laying down the form of a section for a frame or mold, the thickness of the planking must be taken off all around the outside in order to obtain the actual form for the frame or mold. This operation is indicated in Fig. 2.

MAKING THE MOLDS.

The next step will be making the molds, assuming that the boat is of moderate size and that this system is to be employed. The first question will be as to the number necessary in the given case. Here practice varies widely. Some builders use only three to five molds while others use eight and ten. Not less than five should ordinarily be employed, and in many cases the larger number will be found advantageous. To lay out these molds the form must be determined by transfer from the full-sized midship section referred to above. This transfer may be made most readily by using the heads of small nails. As shown in Fig. 3, the nails are laid down at right angles to the line, with head on the line. They are then struck lightly with a hammer, so as to press the head slightly into the floor and thus hold them in place. In addition to marking out the form of the section in this way, horizontal and vertical lines should be indicated as shown. The board is then laid carefully on the nail heads and pressed down upon them. They will thus be imprinted into the board, and a batten sprung through the points will thus serve to reproduce the form of the section. After making one this is used as a copy for a duplicate, and the pair are then put together and finally finished up, as shown in Fig. 4. Last of all it should be compared directly with the section on the floor, in order to make sure that no error has been made and that it is a true copy of the form of the boat at this point. The remaining molds are, of course, made in the same general manner, and this step in the operation is thus completed.

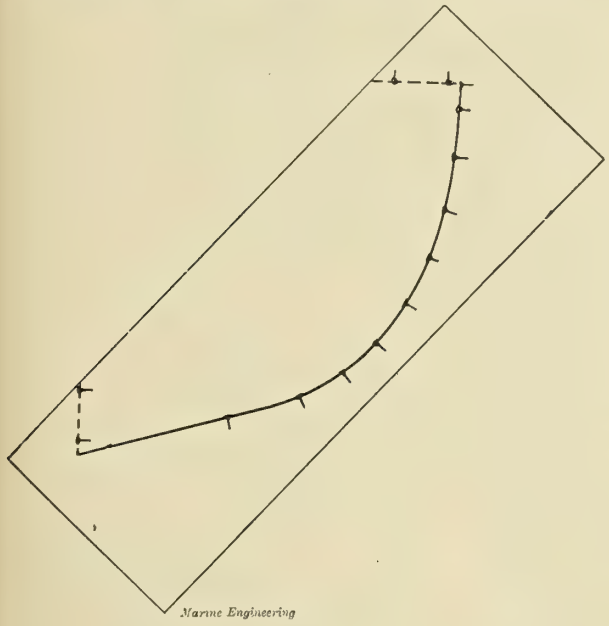


FIG. 3.

We shall next indicate briefly the chief remaining items involved in the work, the order in which the work may be undertaken, and the part which each is to play in the construction as a whole.

METHOD OF CONSTRUCTION.

Keel Support.—This may be of two-inch plank cut to fit the sweep of the keel and blocked up on edge, supported by side braces, so as to furnish a suitable support for the boat and at a convenient height. Care should be taken to so adjust this support that the water line of the boat will be horizontal. This is, of course, no part of the boat proper, and serves simply as a support for the boat while building.

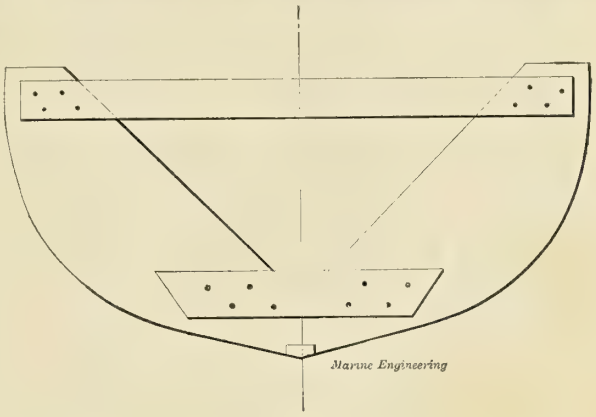


FIG. 4.

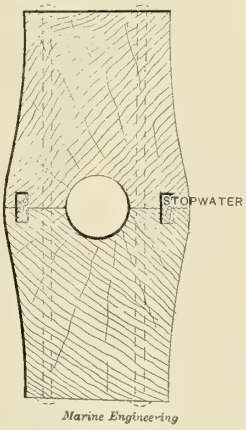


FIG. 5.

Keel, Stem, and Stern Post.—These are usually of white oak and suitably rabbetted to take in the edge of the garboard strakes of planking and the ends at stem and stern. Where a natural crook can be obtained for the stem it should be employed. Chocks should also be fitted in the angle between stem and stern posts and keel, and the whole bolted and secured together as strongly as possible. These various items, after being gotten out separately, may be secured together and erected in place in the keel support referred to above. Figs. 7 and 8 may be referred to as illustrating the relation of these various parts.

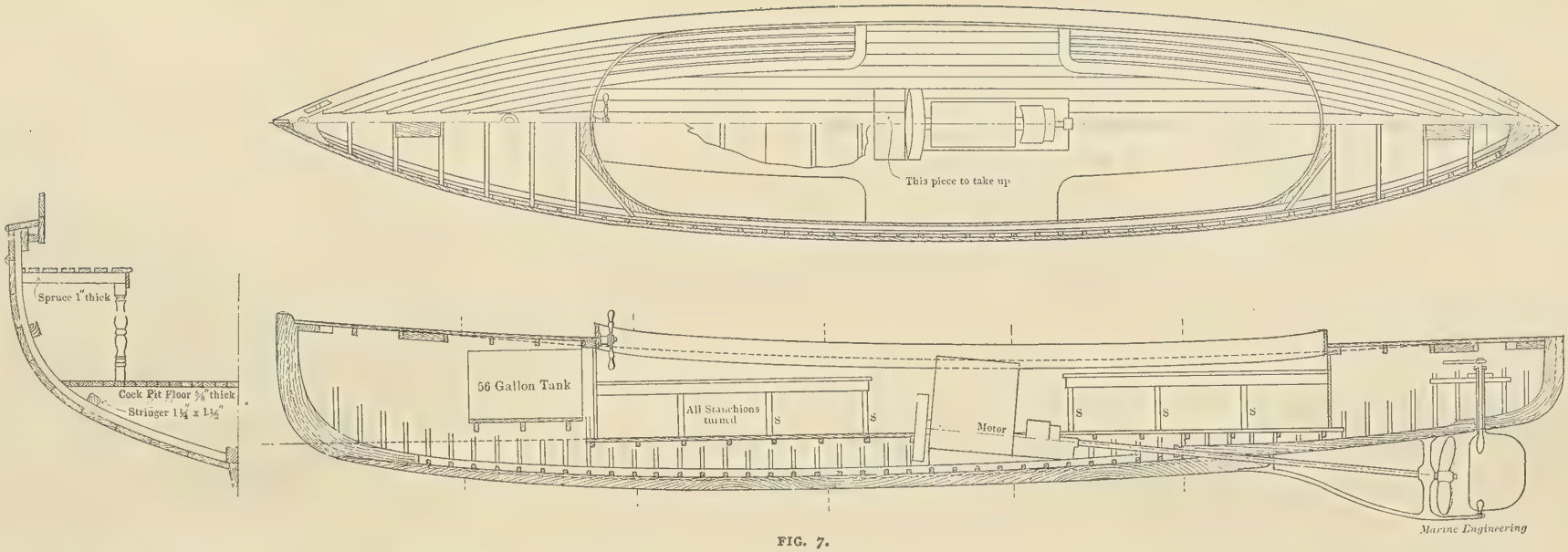


FIG. 7.

Shaft Log.—This is built up on the keel and usually consists of a pair of timbers, as shown in Fig. 5, secured by through bolts, and provided with a hole, as shown, for carrying the stern tube and shaft. The stern post must, of course, be swelled to the same size as the end of the log and provided with the same sized hole. In some types of construction the shaft log is much reduced in length or even omitted entirely. With the flat or torpedo-boat stern, as in Fig. 7, the arrangement will naturally be somewhat different, as indicated by the diagram.

All joints in this fundamental part of the framing should be carefully made with thick white lead and drawn tight with through fastenings where practicable.

Molds.—The molds as previously described may now be set up in place and braced or stiffened so as to retain their relative position. They are centered on the keel by reference to the center line on the mold, and are then lined up by referring the center line on the top of the mold to a cord stretched from stem to stern in the center line of the boat.

Ribbands.—These are strips which are bent over the molds and lightly tacked to them from one end to the other along the planking lines. They serve to further secure the molds in place, and will also indicate any

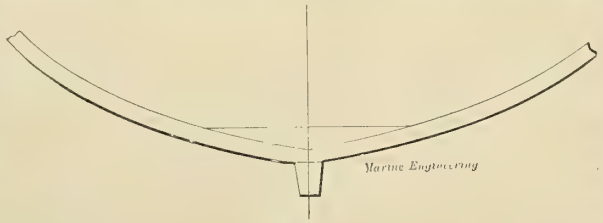


FIG. 6.

unfairness in the form should such exist. The upper ribband should be put on a little above the upper side of the sheer line, so that the sheer strake can go on just below without disturbing the ribband. In small boats, also, the ribbands are readily made heavy enough and the number of molds sufficient so that the frame may be bent directly into place and thus formed without the use of a mold or bending floor.

Frames.—These are usually of white oak, spaced from six to twelve inches or more apart, according to size of boat, and in section from three-fourths inch square upward, according to size and style of construction. The frames should be cut from clear straight-grained stock, air-seasoned and not kiln-dried.

Small frames, as noted above, may be bent directly in place against the ribbands. The frame must first be carefully steamed in a steam box and then taken directly to its place and bent to form. It is then secured to the keel and should be clamped to the ribbands, and finally adjusted carefully in place. For larger construction, and where the frames cannot be readily bent in place in the boat against the ribbands, two methods are available. In one a special mold is cut out around which to bend each frame. In the other a bending floor is used. In preparing to bend the frames by the latter method the form of the section on the inside of the frame is transferred to the bending floor, and then holes are bored and pins

driven in so that their edges come just on the line of the section. The frame is then heated in the steam box, bent to shape, and then secured by boards nailed across, after which it may be set up in place in the boat.

The frames are centered and adjusted in the same general manner as the molds, and, so far as possible, the entire frame from gunwale to gunwale should be continuous. Where there is any considerable rise of floor, however, or where the sections come to the keel at a considerable angle, as near the bow and stern, this will be impracticable, and the frame will be made in two parts, secured together by nailing a board across before setting up in the boat. The frames must be secured in two ways: to the keel and to the skin or planking. They may be secured to the keel by a floor or chock piece, as shown in Fig. 6. Another method is by similar or by bent floors, and the use of chocks between the frames on the keel and an internal keel or keelson securing the whole together, as shown in Fig. 1.

Planking.—This is usually of pine, cedar, or mahogany. Beginning at the garboard strakes or those next the keel, it is put on one strake at a time, tapering each strake at the ends, so as to carry the same number of strakes all the way fore and aft, and keep the line of planking at the edge smooth and fair. The ribbands are, of course, removed in order to make way for the planking, which is thus gradually brought to form and secured in place. For securing the planking to the frames, copper nails riveted over burrs are accounted the best form of fastening. Next come copper nails turned or clinched over. For cheaper work, however, galvanized wrought nails clinched over have been used with satisfactory results.

After the planking is completed a few temporary cross ties to hold the sides from springing should be fitted, and then the molds may be removed.

Engine Bed.—No special details can be given, as so much will depend on the type of engine to be employed. In general, however, the chief danger is in making it too short or too light. It should be understood that the purpose of the bed is to stand the shock and pound of the engine, and to lead the forces which its motion develops away and distribute them as much as possible over the general structure of the boat, instead of allowing them to be localized at that part directly under the engine itself. The foundation in general should consist of two suitable timbers, preferably notched down over the frames and fitted to the planking. They should be long enough to extend over four or five frames or more, and should be braced transversely and secured through the frames and, perhaps, to cross chocks secured to the keel.

Clamps.—The clamps or rail stringers should be made of oak, seven-eighths to one inch in thickness and two to three inches wide, sprung into place on the inside of the frames at the rail, and securely riveted or bolted through and through. The spaces between the frames may be filled in or left open, as desired. No special increase in strength is gained by filling them in, and if open the boat may be more readily freed from water by tipping on the side. In some cases, however, the rail is finished with a cap piece covering over the upper edge of both sheer strake and clamp, as well as the space between.

Bilge and Side Stringers.—These should be fitted in all first-class construction, as adding to the general strength and stiffness of the boat.

Seats.—The seats, whether transverse or fore and aft, should be supported on the skin of the boat by a suitable stringer piece run on the inside of the frames and secured to them. Chocks or knee pieces should also be fitted to aid in giving racking strength. The seat should be carefully secured to the supporting stringer, not so much for the sake of the seat itself, but in order to constitute it a tie or brace for the side of the boat. Transverse seats thus fitted furnish a very effective internal tie for securing the two sides and preventing spreading, which is often liable to occur in small boats without deck beams or other form of cross tie. If the seat runs fore and aft it should also be securely fastened to the stringer, or, better, between two stringers, one above and one below. This will form a very effective stiffener for the side, and will tend to prevent any change of form after the temporary ties are removed. With fore-and-aft seats the inner edge is, of course, carried on suitable posts or supports extending down and carried on a stringer piece attached to the frames.

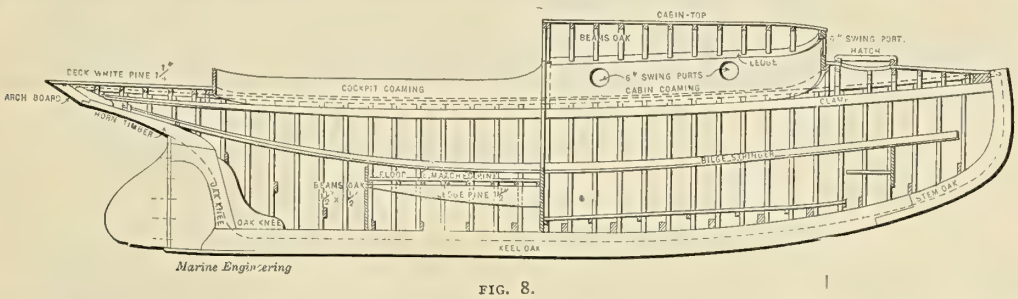


FIG. 8.

Planing and Finishing the Exterior.—After the preceding work is completed, or even before the interior fittings are completed, the outside of the boat may be roughly planed and made ready for calking. The operation of calking the seams is one requiring much skill, and if the services of a professional can be obtained this will be the better plan. If not, the amateur should practice on a few boards nailed together for the purpose. The seam is first opened up a little with a thin chisel, and then the calking cotton is driven in with a thin calking iron. Instead of laying it straight along the seam and then driving it in, a little loop is caught each time, thus greatly increasing the amount of cotton used, as compared with the straight run along the seam. After driving in lightly it is gone over a second time and driven down 3-16 to 1-4 inch below the surface. The seam should then be filled with thick white lead paint put on with a stiff brush. This will soak into the

cotton and aid in making a water-tight joint. The surface may now be finally planed and smoothed up and made ready for painting and puttying. The plane, the scraper, and sandpaper will all find their use here, and it will be found that slight irregularities will disappear, and if the previous work has been well done the form of the boat will come out smooth, continuous, and pleasing to the eye. The painting may then be proceeded with, care being taken to allow plenty of time for each coat to dry before putting on the next following. Each coat should also be rubbed down somewhat before putting on the next, especially if a smooth and first-class job is desired. Three or four coats will be none too many, and if these are carefully put on the result will be an outer surface smooth, hard, and durable. Below the water line some good marine or anti-fouling paint may be used; while above, good white lead, or a white-lead base with such color as may be desired, may be recommended.

The method of construction thus far chiefly referred to has been that in which molds are employed for giving form to the planking as it is sprung into place, and for retaining the form until the necessary internal ties and stiffeners are provided. With larger boats the frames themselves are necessarily much stiffer and the use of molds for this purpose is no longer necessary. The same general mode of procedure is followed with the simple omission of the molds. The frames are prepared and bent in the same general way, and secured in place as already described. This operation being completed, the boat is "in frame," and the planking and other features are proceeded with along the same general lines as above indicated. In boats of the larger size there will usually be a certain amount of deck, and the deck beams will form an important feature in tying the two sides together and in stiffening them against any tendency to change form.

In these brief hints regarding the actual construction of a boat, the general type held in view has been the usual or older type of stern. The changes in detail in the case of a torpedo form of stern are such as may readily be developed from the general principles referred to in the preceding pages. It will be understood, of course, that there are a vast number of details relating to the actual operations involved which have not been discussed, and in particular is this the case in connection with cutting and fitting the rabbett in keel, stem, and stern post, fitting ends of plank in rabbett, laying out taper or planking so as to keep edges fair and retain the same number of strakes, details of the stern, and the fitting of various attachments and features of the equipment. The intention has been only to give in small space such general hints as may prove suggestive to those who are interested in such work, and who may wish to undertake the construction of a small boat without the full assistance of a professional builder.

There will be many problems of practical fitting and procedure which the builder must struggle with and solve as best he may. If, however, the principles above discussed are held in view, and if a fair amount of mechanical skill is at hand, the results should be a boat at least safe and strong, and, what is perhaps worth still more, the acquirement on the part of the builder of much information regarding boat-building operations which he certainly could in no other wise have obtained.

Damage to the Plates on the Bottom of the U. S. Cruiser Brooklyn.

During the naval war game at the eastern end of Long Island Sound last September quite a sensation was made in the daily papers over the fact that the cruiser *Brooklyn* had struck a rock in Narragansett Bay. The damages were not serious enough, however, to prevent the cruiser from remaining with the squadron, and it was not until several weeks later that the vessel was placed in dry-dock in the Brooklyn Navy Yard. An inspection showed that the plates on the port side, about opposite the forward end of the bilge keel, were badly dented, and that in the wake of these dents the other bottom plates were more or less bent. A few of the plates in the forebody were removed after shoring up the vessel, as shown in the accompanying illustration, and then it was found that several floors were badly bent and had to be replaced.

Bids on the New Cruisers.

On January 6 bids for the contracts of the powerful armored cruisers *Tennessee* and *Washington* were opened and are as follows:

Newport News Shipbuilding Company, one ship, $4,325,000.

Fore River Ship and Engine Building Company, Quincy, Mass., one ship, $4,578,000.

Bath Iron Works, one ship, $4,500,000.

Union Iron Works, of San Francisco, one ship, $4,365,000.

New York Shipbuilding Company, of Camden, N. J., one ship, $4,250,000; two ships, $4,150,000 each.

Same company, on its own designs, providing for 22-knot ships, to be delivered in forty and forty-two months, $4,280,000 each. It was in connection with this bid that the letter was submitted demanding an allowance of 25,000 horse power.

Moran Bros. and Company, of Seattle, one ship, $4,397,000.

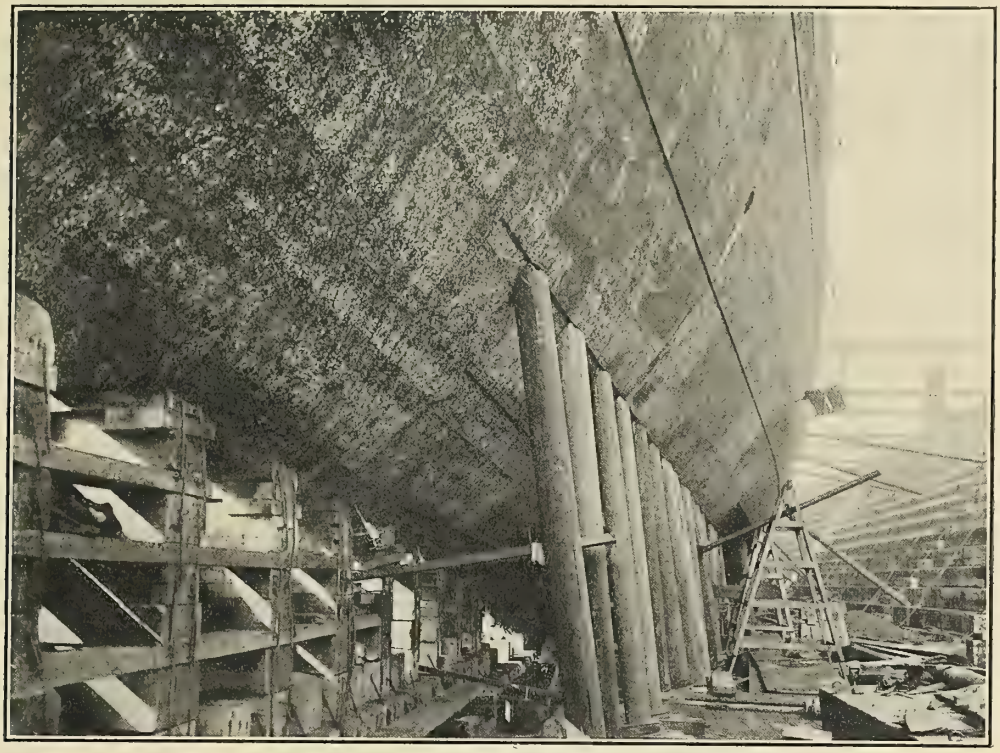
William Cramp and Sons, Philadelphia, one ship, $4,200,000.

Same company, on its own designs, ships to be delivered in thirty-six and thirty-nine months and to be of 22 knots speed, one ship for $4,100,000; two ships on same plans for $4,000,000 each.

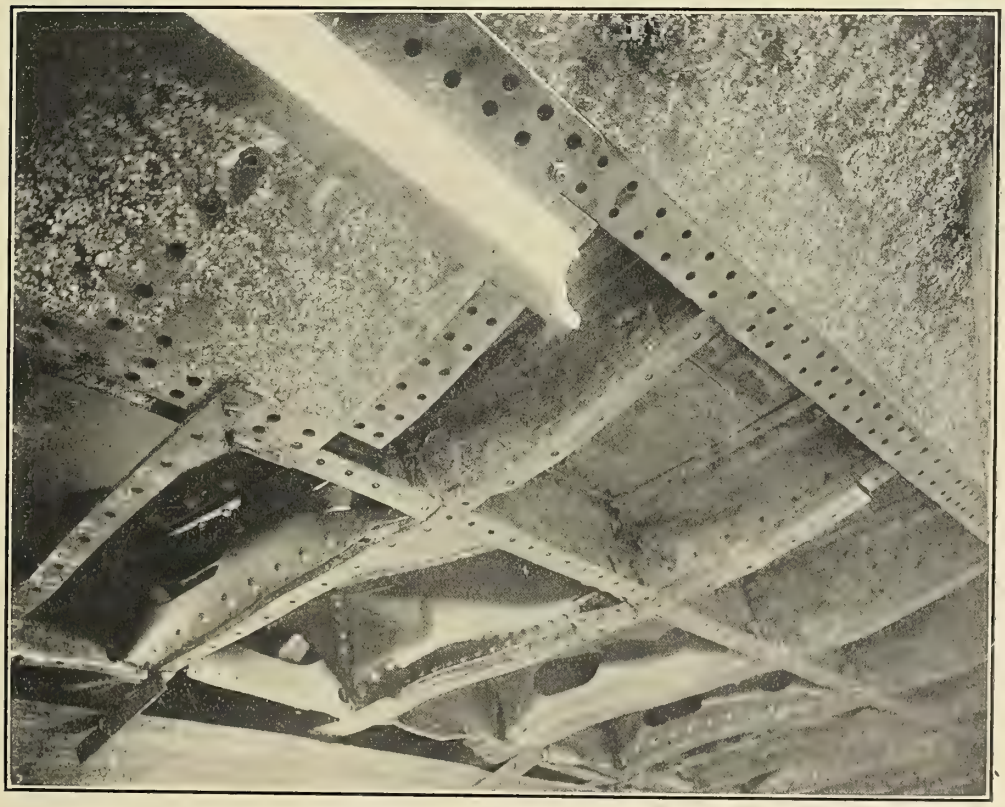
Same company, on plans of its own, providing for the use of steam turbines and water-tube boilers, $4,100,000 for one and $4,060,000 each for two.

After the bids were opened Messrs. Cramp offered to build both ships on the department's plans for the same figure as given for their own plans. The Board of Construction then recommended that this bid be accepted. An interesting three-cornered contest for the contract has since developed, Messrs. Cramp claiming it because of the Board's recommendation; the New York Shipbuilding Company claiming it because it was the lowest bidder for the two, while the Union Iron Works is urging that the contract be awarded that company because, after deducting 4 per cent. from its bid for one vessel, it is within the lowest bid for one ship. This 4 per cent. deduction was authorized by Congress some years ago on the ground that labor and material cost more on the Pacific coast than in the East.

Owing to the importance of the questions involved, Secretary Moody has referred the papers to Attorney-General Knox for a legal opinion as to the authority of the Secretary of the Navy to accept any modification of plans and specifications after the opening of bids. It is the contention of the New York Shipbuilding Company that the Navy Department cannot permit a bidder to change his bid in any particular after the proposals have been opened, the point being made against the Cramp Company.



SHORING UNDER DAMAGED BOTTOM OF THE BROOKLYN.



BOTTOM FRAMING UNDER THE UNITED STATES CRUISER BROOKLYN AFTER THE PLATES WERE REMOVED.

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE field of marine propulsion has long been a favorite with inventors who believe that they have discovered some new and more efficient form of screw propeller or other propulsive device. The principal reasons for this are not hard to find. The interests involved are large and a fortune naturally awaits the man who can displace the screw propeller with something more efficient. Then, again, there is something in a way mysterious about its action, and mysteries are always attractive. Again, it is seemingly simple, a single piece of metal without gear wheels, belts, levers, links, or other complications; it seems attractive in its simplicity and as though any one might safely venture on its improvement. Whatever the reasons in detail, the fact remains and the annual output of new and improved screw propellers or other propulsive devices seems to suffer no decrease. The total number of patents in this field is enormous, and the number still granted each year makes a total which would astonish those not conversant with the facts. It is not our purpose to discourage activity of this character, but simply to note its amount as an interesting fact, and to urge on any who may be inclined to try a hand at improving the screw propeller two or three useful preliminary steps. These are: (1) to become acquainted, so far as possible, with the history of the development of the propeller in its present form; (2) to become acquainted, so far as possible, with the various other types of propeller which have been proposed during this period of development; and (3) to become as conversant as possible with the theory of the propeller in its simpler aspects, and in particular as regards the question of its efficiency under the usual working conditions.

The claims which are so frequently made by those who are concerned in bringing forward freak propellers can only be the result of the most complete ignorance regarding the laws which condition the performance of a propeller, and regarding the fundamental problem of ship propulsion. Thus the inventor or promoter of such propellers will freely claim an increase of speed as compared with the best obtainable by the ordinary form, of from 20 to 50 per cent., or perhaps even more, according as he may happen to make his guess. All this is, of course, absurd. It is well to realize that while the accepted type of screw propeller is far from perfect, and while it is doubtless susceptible of improvement in various ways, still at the most the margin left for gain is relatively small. A few facts will make this clear. Propellers of the usual type and operating under fairly suitable conditions have an efficiency of from about 66 to 70 per cent. If this 30 to 34 per cent. which is not directly used for propulsion could be so utilized, the speed would be increased by about 15 per cent. This is the entire margin so far as speed is concerned. But may not some inventor devise a propeller which will realize the entire margin, moderate though it may be in comparison with the larger figures quoted above? Yes, we may answer, on the same day on which he lifts himself over a fence with his boot straps.

There are some things which we cannot do, at least so long as the laws of mechanics remain as they now are. We cannot propel a ship without setting in motion sternward a column of water from which to derive the propulsive thrust. No matter how perfect or ideal the propeller may be, no matter how completely we may be able to avoid the losses due to friction, to the formation of eddies, to rotation and to various items which in the usual propeller are believed to give rise to losses of energy, the expenditure necessary to develop the sternward motion in the column of

water acted on will always exist. While the extent of the loss will vary somewhat, it can scarcely be made much less than 20 per cent., or, in other words, if all other sources of loss were avoided the maximum efficiency would be not far from 80 per cent. Since these sources of loss relate to the form of propeller, size, shape, and surface of blades, etc., it may be fairly said that mechanically this 10 to 14 per cent., lying between the actual and ideal efficiencies, represents the actual margin which the inventor has before him in the attempt to improve the present type of propeller. Could he compass the saving of this entire margin, the increase in speed would be about 6 per cent. This, then, is the full possible margin, and it is very sure that no form of propeller acting directly on the water will ever be able, with the same power, to effect a greater increase in speed than some such margin, as compared with the speed given by a suitable propeller of the usual form. Improvements in speed greater than this have, of course, been reported as the result of a change in propellers. In such cases, however, the presumption is that the first form was not suitable and hence inefficient. The only fair comparison is when each form is allowed to do its best, and with this understanding there is no possibility with the same power of an increase in speed greater than close about the 6 per cent. mentioned above, and practically there is no possibility of this without some change in the laws of liquid friction, formation of eddies, etc. The field, however, is open, and all interested will welcome such improvements as may come, small though they may be in comparison with the visions of those whose enthusiasm in such matters is not ballasted with a knowledge of the fundamental facts in the case.

THERE seems to be nothing in either the size or speed of the new Cunard steamers looking toward an indication of a limit in such matters. The advance during the past fifteen years—the period covered by the modern twin-screw Atlantic greyhound—has been continuous in both size and speed from the 525 feet, 14,000 tons displacement, and 20 knot speed of the former *Paris* and *New York* to the 720 feet, 30,000 tons displacement, and 25 knots of the present designs. Throughout this history the advance has been conditioned on one inexorable law, that advance in speed can only be obtained by increase in size. This presupposes, of course, a generally similar type of construction, and a similar relation between the power and the weight required for its development. This has in the main been fulfilled. While much advance in detail has been made, and while water-tube boilers and the possibilities of turbine engines seem to promise substantial advances in power per ton of weight, still the gain thus far assured has been only moderate, and by no means sufficient to compensate for the requirement of added size. In short, torpedo-boat construction is a type not fitted to mercantile conditions nor to large-sized ships; and while the present size of a boat necessary to maintain a speed of 25 knots is somewhat less than if the engineering conditions of the *Paris* or *Teutonic* were exactly reproduced, still the gain has not been sufficient to make possible any great advance on the same size. It is perhaps doubtful if otherwise the sizes of the Atlantic express steamers would have been increased in anything approaching the same proportion. It is true that large size has some advantage in itself, and that the past few years have witnessed a marked increase of size in the moderate speed freight steamer, where cargo capacity and not speed was the prime requisite, and where the increase in size was the result of a demand for more capacity rather than for higher speed. Here still, however, the same general law has its effect, and the large freighter gains its advantage by carrying a ton of freight at a lower cost per mile than the smaller boat.

The point of this is that the progress in the future will be conditioned on the same general laws, and that further increase in speed will require either a pronounced change in the relation between power and weight or still further advances in size. Regarding the former, oil fuel, the water-tube boiler, and the steam turbine form our chief hopes, but the extent to which they may be able to furnish increased speed with the same size, or the same speed with reduced size, can only be determined by the experiment on a full-sized scale. Regarding the increase in size, the difficulties to be met with are more likely to be those relating to harbor and docking facilities than those of shipbuilding itself. Constructively a ship 1,000 feet long might undoubtedly be built, if desired, and probably with less difficulty than that met with in berthing, handling, and caring for her after her completion. The demand of the age, however, seems to be for reduced time and higher speeds, and this demand will undoubtedly be met in one way if not in another. For the detailed route we must await developments of the coming decades.

Troubles with Piston Rings.

Editor Marine Engineering:

Having been shipmates for the past four and one-half years with a peculiar set of engines, and one that varies considerably from the ordinary, I thought that a partial description of them, of the ills they were heir to and some of the remedies that were applied, would be of interest to your readers. The engines, driving twin screws, are inverted, direct-acting, three-cylinder, triple-expansion, with cylinders 31 1-8, 46, and 70 inches by 30 inches stroke. Each engine is worked from outboard; the air pump, being back of the go-ahead guide of the L.P. cylinder, is driven direct from the piston by a rod extending down through the bottom of the lower head of the L.P. cylinder. The circulators are of the independent centrifugal type. The main condensers are between the L.P. cylinders and the fore-and-aft bulkhead between the engine rooms, and connect to the L.P. cylinders by a short copper expansion joint. The H.P. valves are of the piston type, while the I.P. and L.P. are of the double B type, with four steam ports and single exhaust port. These engines are very short connected, the main-bearing caps being flush with the floor plates, while the bottom of the L.P. cylinders is only 5 feet 5 inches above the floor plates. This necessarily brings about very short eccentric rods and a very erratic valve motion, the radius of the links being only 4 feet 4 inches, while they are about 4 inches square and 4 feet long, of the solid-bar type.

I was detailed to this ship on April 26, 1898, and we sailed before having a chance to examine the machinery. From the start the engines worked very unsatisfactorily; they backed badly, the links of the I.P. and L.P. "slotting" nearly 8 inches in the back motion. The pistons were apparently traveling all over the cylinders, and top and bottom end pins and main bearings thumped like modern steam hammers. After being constantly under steam from about May 3 till the latter part of August, we then had a chance to open cylinders for examination.

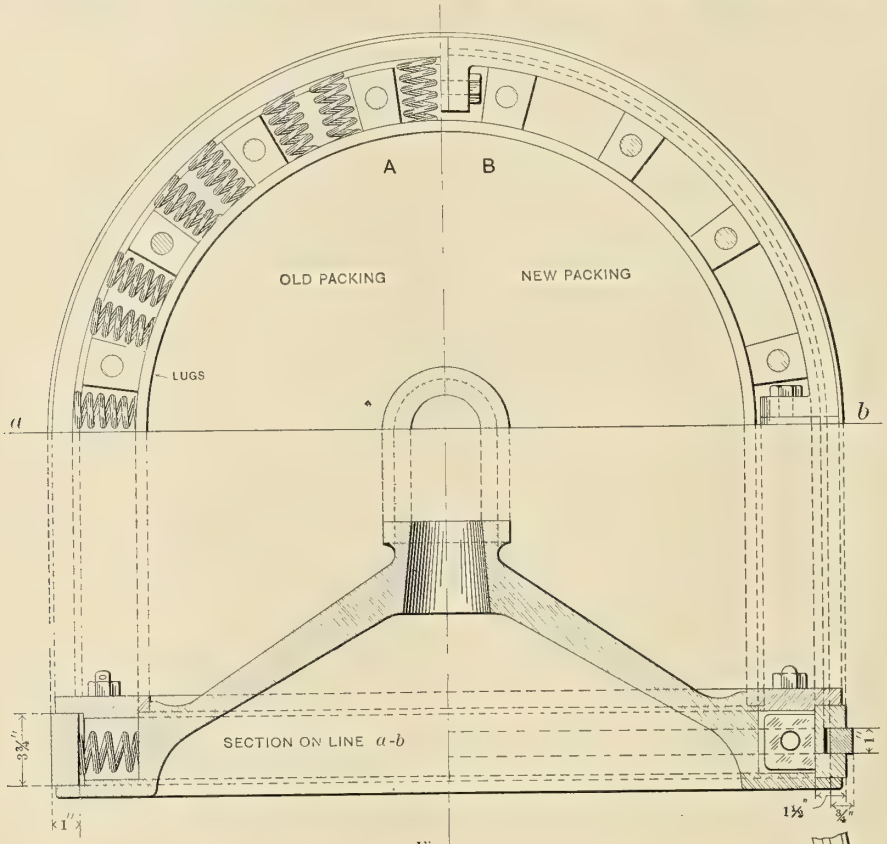


Fig. 1.

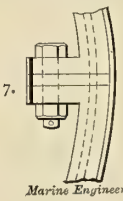


Fig. 7.

Marine Engineering

The pistons of all cylinders were fitted with rings and springs, as shown in the quarter of sketch marked *A*, Fig. 1. The springs were hurriedly removed and packing rings lifted, cleaned, and replaced. At this time it was observed that the pistons were nearly a half inch less in diameter than the bore of the liners, which of course threw the work of steadying and guiding the piston entirely upon the rings and springs. The rings showed very badly on the wearing face and had a dragged dull surface, due to excessive wear and friction. The liners

were of a very hard, close-grained iron, not in the least scored or cut, and were from all appearances a good job. From time to time the question of fitting new rings of a different type was brought up, but not acted upon.

We left New York on October 20, 1899, and started our run of 13,000 miles for Manila. Up to the time we arrived at Colombo, Ceylon, we had made three stops for coal, and at each stop we examined and cleaned cylinders, oiled them, and tried follower bolts. The first night out from Colombo eight of the follower bolts of the port H.P. piston let go without any warning. After a bump or two the engine was stopped, the bull's

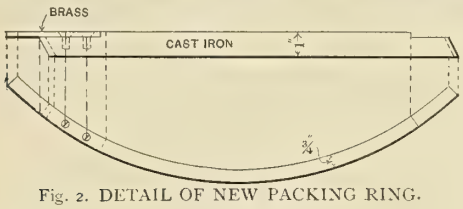


Fig. 2. DETAIL OF NEW PACKING RING.

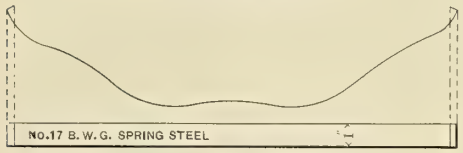


Fig. 3. NEW RING SPRING.

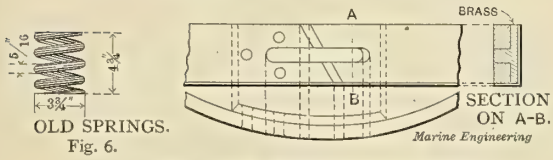


Fig. 4. OLD PACKING RING JOINT.

eye in cylinder cover removed, and the cause of the bump discovered by the missing follower bolts. We at once removed the cylinder cover and found that the bolts had let go at the square, where they were screwed into the piston lugs. Twenty-eight pieces of the steel bolts and nuts were found on top of the cylinder liner and carefully matched together; then it was found that one nut and one and one-half studs were still missing. On removing the bottom relief valve of the H.P. cylinder the missing pieces of the stud and one-half of the nut were fished out with a wire from lower steam port. This left only one-half of a 1-inch bronze nut missing, and this was finally found in the steam-chest drain of the I.P. engine. Our port engine was stopped about 24 hours to drill out eight 1-inch steel studs, make eight new ones, get them in place and secure. Frequent examinations after this showed all of the cylinder rings to be wearing excessively and not in any way improving the wearing surface of the liners.

While in Nagasaki, Japan, in March, 1900, having some other work done, it was decided to replace both H.P. piston rings with new ones of the same type as the old ones, it being thought at this time that the iron in the rings was too hard. By actual measurement the rings were found to stand open on the tongue piece (see Fig. 4) about 1 3-8 inches. A new set of H.P. rings were fitted and left open 1-32 inch, and we started on our return voyage to Manila. The second day out the piston rods and valve stems on both sets of H.P. and I.P. engines were beginning to cut, and as the packing (Duval's braided wire) on all these rods had not been changed for a number of runs, aggregating about 20,000 miles, the trouble was attributed to the cutting of the new H.P. rings. On first leaving Nagasaki, with the engines turning about 80 revolutions, a constant clattering noise began in the H.P. cylinders, and on the second day out it became worse and fully equaled a boiler shop or a Chinese band. A little cylinder oil used in the H.P. cylinders somewhat deadened the noise, but did not stop it altogether. On our arrival at Manila the cylinders were examined and the H.P. liners found to be in fair condition, but on lifting the followers the new rings were found to stand open 1 5-8 inches. We then took out every other spring to lessen the friction, and fitted another set of new rings which we kept for spare.

The ship then cruised for about six weeks along the northern coast of Luzon. The weather continued fair and we called at several ports, sometimes two a day, but always were under steam. On returning to Manila the rings were thoroughly examined and found to be no better and not much worse. We sailed again on August 15, 1900, for Woo Sung, China, and for six days were in a typhoon on the China Sea, the ship rolling heavily. As many of the springs in the H.P. cylinders had been removed, the rolling movement caused a bad side slap of the pistons and reminded us that we had removed too much of the spring load from the packing rings. While lying in the river at Woo Sung and afterward for a couple of months off Taku, the question of a new design of packing ring came up. It was found that the H.P. cylinder cover might be removed, the follower and packing ring taken out and replaced and secured in about eight or nine hours. So this became a very easy problem. We designed a single solid ring of the same dimensions as the old ring, except we turned the ring to fit the bore of the liner and bored it to fit over the piston lugs, so as to remove all slack between the cylinder walls and the piston. Into this bull ring a groove was turned to take a ramsbottom ring 1 inch wide and 3-4 inch thick.

That finished the H.P., but the I.P. and the L.P. were a far different problem, because of the scant space between the protective deck and the top cylinder covers, the distance in the clear being 12 inches for the H.P., 10 1-2 inches for the I.P., and only 8 inches for the L.P., as shown in Fig. 5. From the shape of the L.P. heads it was found barely possible to remove the old packing ring and follower, even by removing the balance piston and cylinder of the L.P. valve, and it was estimated the work of removing and securing would occupy about three days. The I.P. would require for the same work about two days. This was entirely too long a time to disable the engines, as many of the harbors on our station had poor protection and poor holding ground. Therefore scale drawings were made for a sectional ring for the I.P. and L.P. engines, to combine all of the good features of a solid ring, so as to steady the pistons, and to carry a packing ring for the sole purpose of making them steam-tight without the excessive friction of the old rings. In Fig. 1 I have shown in the sketch, which is not to scale, a quarter section of the old and new packing rings, both in plan and cross section. By referring to section *A* of the old packing and springs it will be seen how the strain of

steadying the piston was thrown on the ring and springs. In section *B* of the new rings is shown how the space between the cylinder walls and the piston lugs is taken up by the new bull ring and the piston kept central. In this sketch I have shown the packing ring forced out by the spring as it would be before putting in the cylinder. When the packing ring is in place in the cylinder it only projects about 1-64 inch outside of bull ring. By making the new bull ring, packing ring, and springs sectional it was found that by swinging the followers in the top of the cylinders the packing ring could be raised and blocked up above the piston, then unbolted and the sections passed out through the bull's eye in the top cylinder cover, and then cleaned, replaced, and secured in less than eight hours. This was of course a great improvement over any kind of ring that would necessitate the removal of the cylinder heads.

The new bull rings were made a trifle fuller in depth than the old rings, so that the follower would "nip" the ring solidly, and the piston thus have all of the advantages of a solid piston. We had the new rings made in Shanghai, and when they were ready we cut the old rings in three pieces and passed them out through the bull's eyes. The new rings, properly marked, were then passed in by sections, the distance pieces fitted, bolted up, and then dropped into place. As the new ring had to be bolted up on blocking, the distance pieces became a necessity, so that the last section could be shoved out against the cylinder walls squarely. The distance pieces thus crowded all of the rings together, so as to allow more space for the last ring to be put in place. The lugs on the new sectional ring were spaced so as to drop into the pockets in the piston that were occupied by the old springs. These lugs and distance pieces are shown in the ring detail, Fig. 7. The bolts in the lugs were turned and the holes in the lugs and distance pieces reamed, thus making a good fit. Fig. 2 shows a section of the new packing ring as fitted, there being six sections in the L.P. and only three in the I.P.

The springs as fitted are shown in Fig. 3 and are made from spring steel 1 inch wide and slightly corrugated to give the proper spring. The ends of the springs were turned up slightly on each end, so as to prevent the springs riding or slipping by each other.

The old spiral springs, Fig. 6, were compressed 5-8 inch, and with 32 in the L.P., 24 in the I.P., and 16 in the H.P., it will readily be seen that the friction load on the old rings was enormous. By actual weighing, the load required to compress each spring 5-8 inch was found to average about 50 pounds for each spring. This would give $32 \times 50 = 1{,}600$ pounds for the L.P., $24 \times 50 = 1{,}200$ pounds for the I.P., and $16 \times 50 = 800$ pounds for the H.P., which, divided by the square inches of bearing surface, is about 2 pounds for the L.P., 2.2 pounds for the I.P., and 2.4 pounds for the H.P. per square inch of bearing surface. The friction load of the new spring was less than .2 pound per square inch of bearing surface. It can be seen that at a maximum speed of 157 revolutions and a piston speed of 785 feet per minute, the unusual wear on the old rings would be easily accounted for. Since installing the new rings and springs, over twenty months ago, this ship has steamed a good many thousand miles at all speeds. The rings have been taken out and examined regularly every three months, and have always been found to be in perfect condition; the cylinders and the rings are beginning to show a very fine polish.

I have seen this ship with the old rings and springs make 90 revolutions with both engines on two of the main boilers, but this was pushing her very hard, while with the new rings and springs we averaged 99 revolutions from Nagasaki to Manila on two boilers.

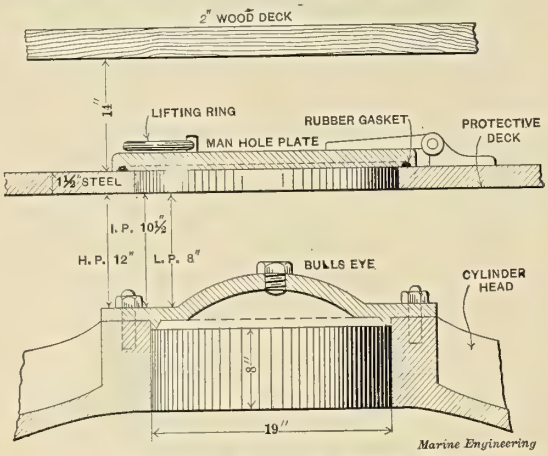


Fig. 5. SECTION THROUGH BERTH DECK, PROTECTIVE DECK & CYLINDER HEAD.

The cylinders are opened, cleaned, and wiped out with a little cylinder oil after each run. Other than this, no cylinder oil is used whatever. The principal dimensions of the ship are:

Length on water line	346 ft. 0 in.
Beam, extreme	43 " 9 "
Mean draft	18 " 0 "
Corresponding displacement	3,769 tons
I.H.P.	7,500
Propellers	2
Diameter	12 ft. 0 in.
Pitch	15 " 9 "
Boilers	4 double-end Scotch
Diameter (mean)	12 ft. 1 in.
Length	17 " 10 "
Furnaces	Three in each end
G. S., each boiler	120 sq. ft.
H. S.	3,594.5 " "

A. E. B., U.S.N.

Securing the Brass Seat in Steam Stop Valves.

In the repairs to ship machinery I have often noted that the seat rings of large cast-iron or cast-steel steam stop valves are secured as shown in Fig. 1. The lower part is cylindrical and fits firmly into the metal of the casing. Extending from the valve seat is a flange *F*, as shown, which serves to secure it to the casing, a red-lead joint being fitted under the flange so as to prevent all possible leakage

This practice is open to some objections. Thus, to put the valve-seat ring in place it must be passed through the upper opening *A* in the casing. In consequence of the seat-ring flange, we must make this opening much larger than would serve for admitting the valve, and thus the diameter of the cover is unnecessarily increased, with corresponding increase in the number or size of the studs necessary to secure it to the

casing. The necessary drilling and tapping required for the seat studs is also rather difficult and adds to the cost.

A somewhat different system, which has given excellent satisfaction, is shown in Fig. 2. The valve-seat ring is made slightly tapering and fits into a corresponding bed in the casing. The diameter *B* is not more

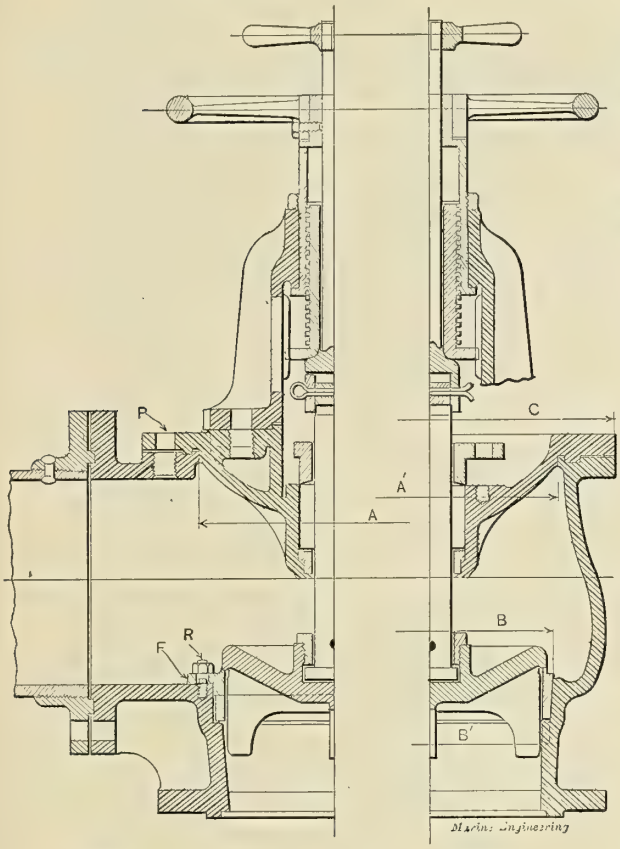


FIG. 1. FIG. 2.

than 3-64 inch greater than the diameter B^1, such taper being found suitable for the purpose. With this arrangement also the ring may be tried in place and adjusted before being finally forced home. For the latter purpose a strong back and bolt may be used, as in Fig. 3.

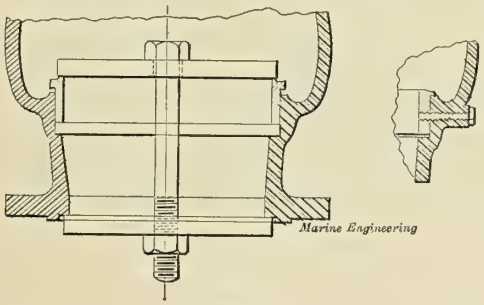


FIG. 3.

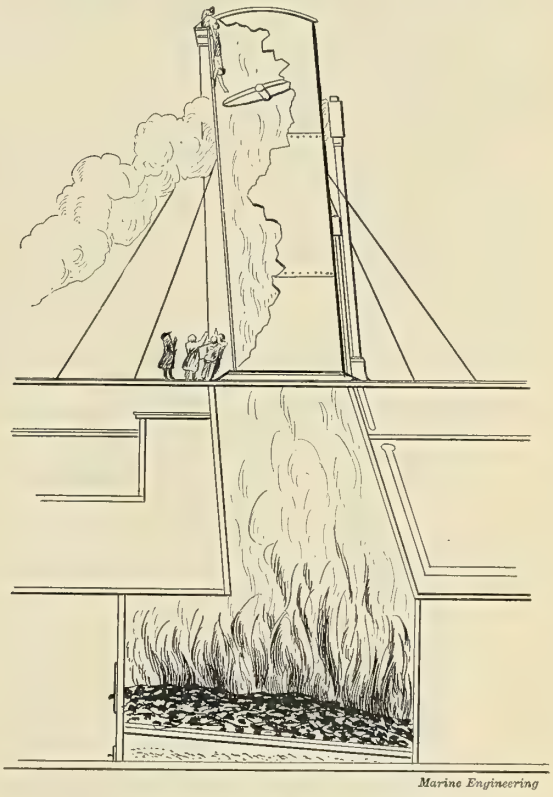
This manner of securing the seat ring in a cast-iron or cast-steel valve casing is evidently secure, for, due to its conical form, it will act as a wedge, and when tightly forced home will remain fixed without other means of fastening. It is also economical of space, for the flange *F*, Fig. 1, is not required and the work of fitting the studs *R* is also saved. The opening of A^1 in the casing, Fig. 2, can also be made less than *A*, Fig. 1, and thus a general saving is effected on the cover and its fastenings. For final security, if desired, the seat ring may be locked by a simple screw, as shown in Fig 3.

D. Attilio.

The Boiler from a Reporter's Point of View.

Herewith is produced from one of the New York dailies a remarkable sketch illustrating the brave act of an engineer on board the steamer *La Champagne*. From the paper's account we cull the following details:

The latch securing the damper in the after funnel became unfastened and the damper closed, thereby shutting off the draft to half the battery of boilers. An oiler who was ordered to the top of the stack to see what



BOILER REPORTED TO BE ON STEAMSHIP.

was the trouble was overcome with the gases and hung balanced on the rim of the funnel. An engineer named Pommier then climbed to the top and brought down the unconscious man. Pommier again ascended the stack and, while a seaman grasped his ankles, lowered himself head-first down the inside of the funnel and replaced the latch on the damper.

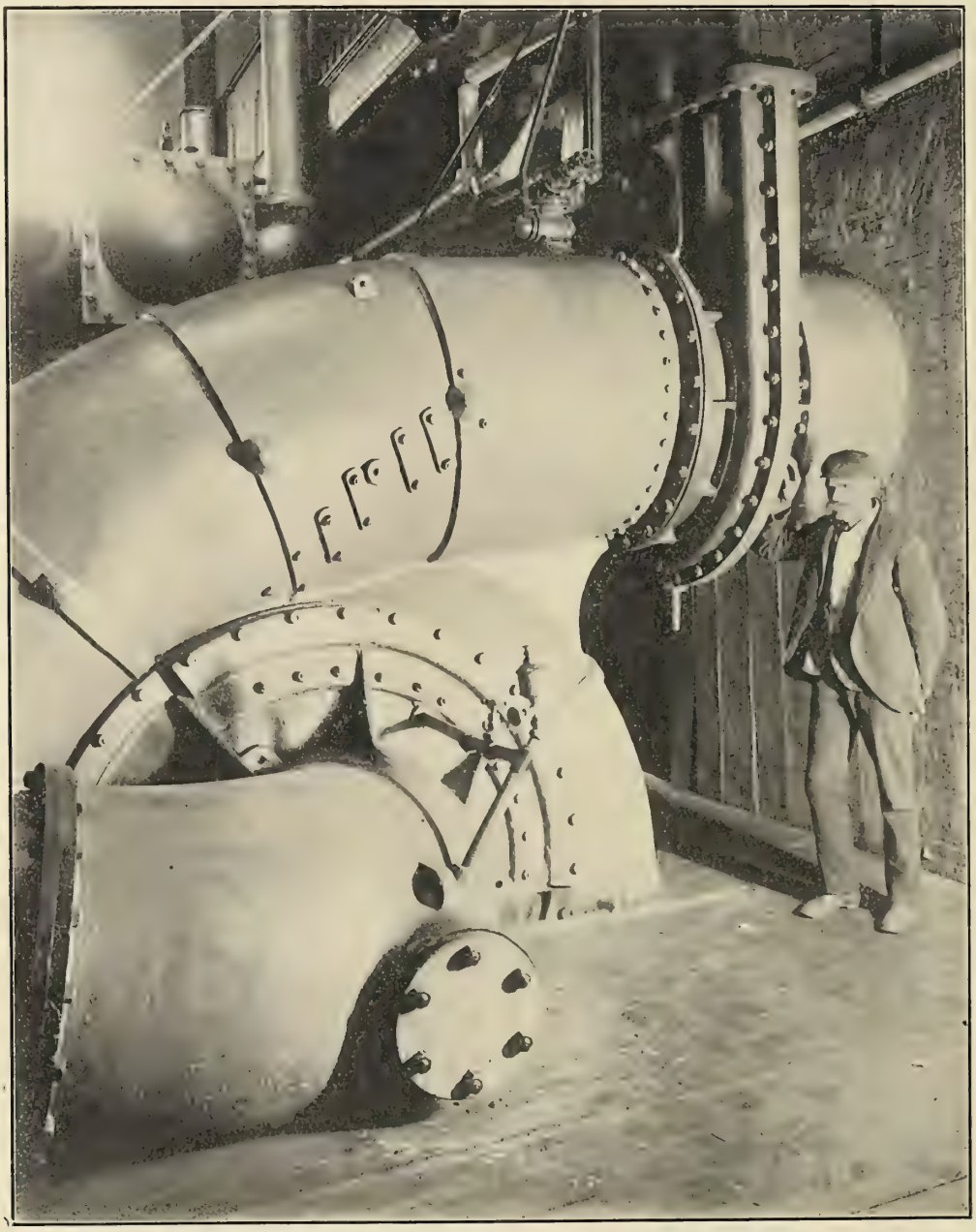
The point of interest to our readers will, no doubt, be the section of the "boiler" and uptakes. The boiler should evidently be classed as the fire-tube type, as there is nothing to indicate the presence of water in tubes or cylinders, or anything of that kind. In fact, the outfit looks more like a retort. The sketch is subject for thought. Ridiculous as it is, it illustrates how absolutely ignorant the general public is of all classes of machinery.

ENGINEERING SPECIALTIES.

Smooth-On Iron Cement.

Many breakdowns incidental to machinery subjected to steam and hydraulic pressure can be successfully repaired by use of the material known to engineers as Smooth-On iron cement. The uses of this material in repairs are numerous, and one of these, shown in the engraving, is of the repairs to a large centrifugal pump in a dry-dock pumping station, Brooklyn Navy Yard.

The pump and 48-inch discharge pipe split almost in two about four years ago, due to a sudden strain, the crack extending for about 20 feet and in some places opening up to three-quarters of an inch. To replace the pump with a new one would have required many months, and the dry-dock could not have been operated without the pump. It was decided to use Smooth-On, and within three days after the breakdown the pump was running, and continued successfully in service for thirteen months, when it was replaced by a new one. The second pump broke in about the same place one and a half years ago, and it in turn was repaired with this iron cement, as shown in the cut, and from that day to this has not given any trouble.



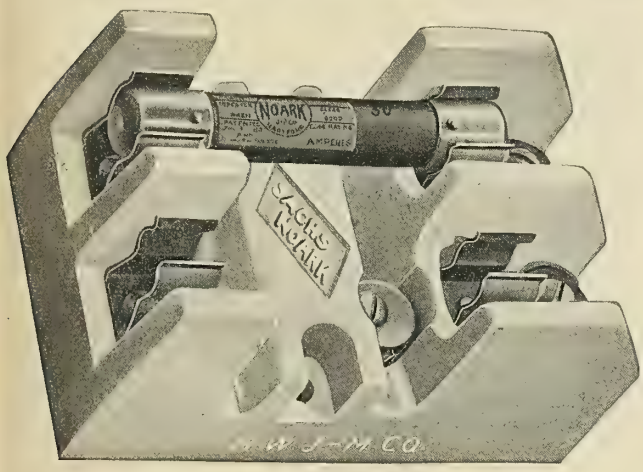
CENTRIFUGAL PUMP, BROOKLYN NAVY YARD, REPAIRED WITH SMOOTH-ON.

Smooth-On is a metal cement, which, properly mixed with water, metalizes and expands. The method of making the repairs consisted in fitting a patch on the inside of the fractured pipe. The metal under the patch and in the seam was covered with a thin layer of the

iron cement, and the patch was secured by bolts, as shown in the engraving. Repairs to the housing were made by fitting a patch on the outside, cutting the two surfaces of the metal, and then drawing up the patch with bolts, as shown. Three years ago the suction pipe of this pump broke in two under the ground, due to settling, and this break was repaired with this iron cement and has given good service ever since, showing the practical use of the material when applied by skilled engineers. This iron cement is made by the Smooth-On Manufacturing Company, of Jersey City, N. J.

Branch Fuse Blocks.

To meet the demand for enclosed fuse branch blocks, the H. W. Johns-Manville Company, 100 William street, New York, has placed on the market a line of single branch blocks, one of which is herewith illustrated. A departure has been made from the usual arrangement of branch block devices in which fuses for the branch sockets abut at right angles to the outside of the two or three parallel main wires. This construction requires a block of some size, owing to the fact that it is necessary to give space for the main wires and branch fuses separately. In the "Noark" branch blocks the object

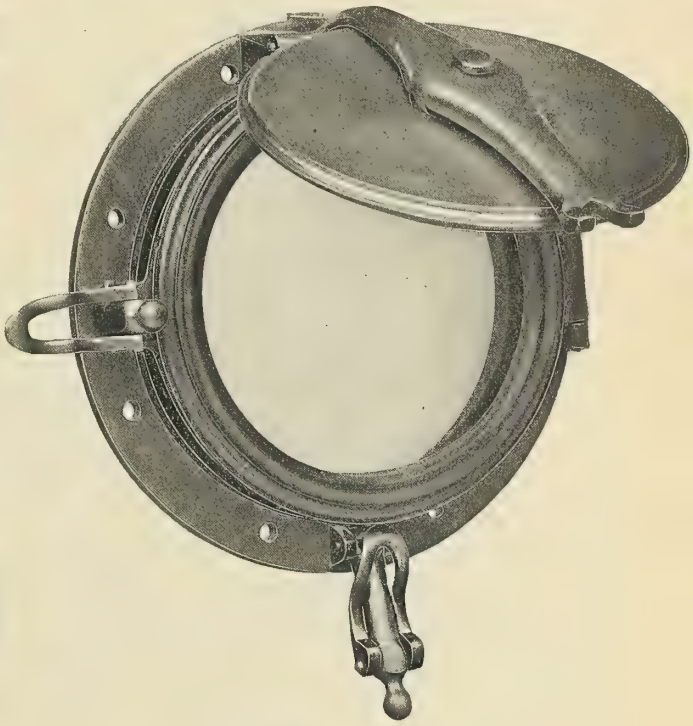


BRANCH FUSE BLOCK.

has been to economize space and at the same time produce a branch block in which the arrangement of the wires and fuses should be absolutely safe, both in the operation and manipulation of the device. To obtain this result the branch fuses are so arranged that each of the terminals in which the branch fuses are received and to which the branch wires are connected are separated from the adjoining terminals by heavy partition walls, high enough above the contacts to prevent anything being laid across from contact to contact and cause short-circuiting. This feature is also predominant in the main blocks. The main wires to which the branch block is connected, instead of passing across the block at the end of the branch fuses, are arranged to traverse it in suitable grooves placed in the porcelain block between the terminals of the branch fuses. In this way a great economy of space is effected, while at the same time the block can be easily and readily installed and the manipulation of the fuse devices for a removal or insertion is entirely safe.

One-Snap Air Port.

An air port has recently been placed on the market, manufactured by the Delaware Marine Supply Manufacturing Company, Incorporated, of Wilmington, Del., which embodies several new features of design and has overcome the objections met with in making a water-tight, quickly-operated air port. The special features of this air port are: that the glass and deadplate are each closed by one operation by an eccentric snap and the pressure is evenly applied to all parts of the rubber filler in the rings. All the material is brass, and the ring itself has a faced surface on which the rubber bears. The glass is carried in threaded male and female rings, which, when tightened up, compress the putty into all open space, acting as a stuffing box and making the



NEW DESIGNED AIR PORT.

joint absolutely water-tight. This ring is carried by a loose hinged band which is in contact with the ring at two points diametrically opposite to it. Each side of the ring has a rubber filler. To close the air port the glass supported in the band is swung down and the eccentric snap, which catches on the band, is turned. This snap will at all times give the same pressure for closing the port, but may be adjusted to take up any wear. There is, therefore, no danger of the ring being sprung or the glass broken, as when dogs are used.

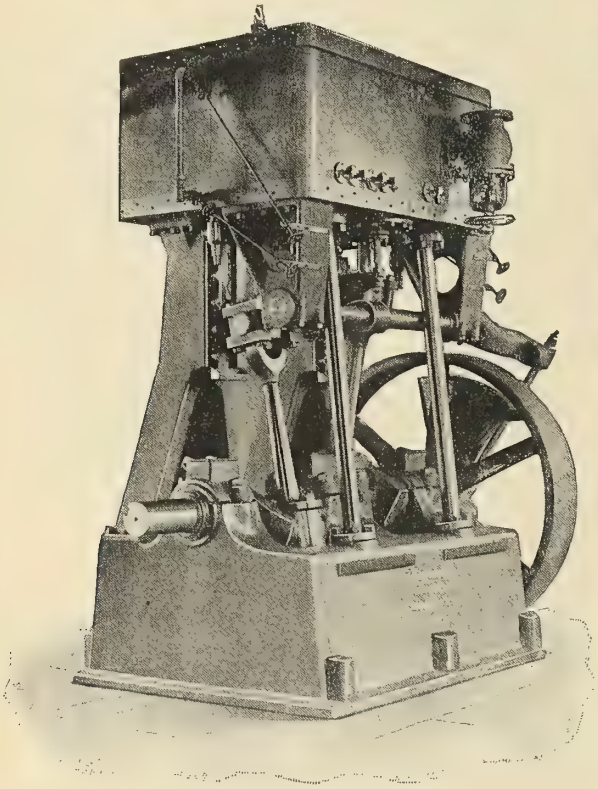
The deadplate has a hinge at right angles to that of the glass and is supported at the center by a yoke. A similar eccentric snap catches the yoke and brings the deadplate down upon the rubber ring with an equal pressure at all points.

These air ports, which are made in different sizes and finish, are well designed throughout and specially adapted for passenger steamers and yachts. This principle of making the glass and ring water-tight is carried out in all the air ports and deck lights made by this company.

New Compound High-Speed Engine.

To meet the demand for engines of larger capacity than those heretofore made, but of the same quality of workmanship and general design, the W. D. Forbes Company, Hoboken, N. J., has produced an engine, herewith illustrated.

The cylinders are 14 and 28 inches diameter, with a stroke of 16 inches, and the revolutions per minute will be between 250 and 300. Both high and low pressure cylinders are fitted with piston valves, one controlling the steam on the high pressure, and two on the low pressure cylinder. The valves are of the usual plug style made by this company and work in liners with machined ports. These valves are actuated by a rocker shaft,



HIGH-SPEED COMPOUND ENGINE.

which is supported on brackets, as shown. The governing is done by a Rites automatic governor, which is too well known to require any description, except to say that the governing of these engines is sufficiently close to satisfy the conditions of running generators in parallel for alternating-current machines.

The crank shaft is made from a solid steel forging, and the connecting rods are of the torpedo-boat style, the lower ends being fitted with bronze bushings, while the upper or forged end is fitted with the marine style of brasses. The crosshead is forged from the solid and fitted with a bronze shoe; piston rods are fitted to the pistons and the crossheads with tapers; the pistons have double rings, and the low pressure is fitted with a follower. The usual relief valves are placed on top and bottom of the cylinders, and the oiling system, which does not show in the illustration, is ample, oil being fed from large cups to the various parts of the engine, sight feeds being conveniently placed so that they can be readily seen and adjusted. The main bearings are provided with bronze shells or bushings.

Great care has been exercised throughout in the selection of material. Although the engine shown was gotten up for electric-light work, it can, of course, be used for general shop drive and for many purposes, such as driving centrifugal pumps, large blowers, etc.

New Method for Coppering Ships.

The Coleman Ship Coppering Company, of Boston, Mass., has been recently incorporated to exploit certain patents which cover various processes for coating with pure copper the hulls of vessels and other structures, either of wood, iron, or steel, for the purpose of preventing corrosion, fouling due to vegetable or animal growths, or, as in the case of piles, their destruction due to the ravages of the teredos.

COATING A SHIP'S BOTTOM WITH COPPER SPRAY.

The process consists, briefly, in covering wood or steel with a matrix paint, into which is blown, under air pressure, finely divided pure copper, thus obtaining a smooth and durable metallic surface at much less cost than where sheet copper or yellow metal is used for the purpose.

In case of iron or steel a layer of fine quartz embedded in a matrix is interposed, as an insulator, between that metal and the copper coating, which is found after exhaustive tests to absolutely prevent any electrolysis or pitting of the steel plates.

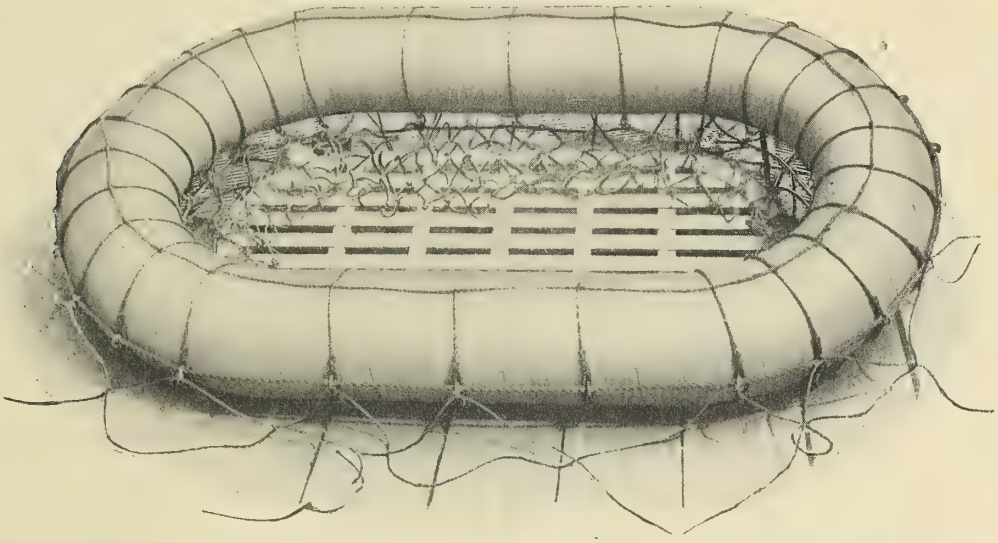
Professor Elihu Thompson recently made several careful tests to determine if electric contact was established between the copper and the iron of the coated plate when the plate was subjected to violent abrasion by glancing and direct blows of a hammer and by forcibly driving the plate between vise jaws. There were no indications of electric contact, even though an 110-volt current was used for testing.

The special advantages of this process to yachts and small vessels are the uniform smoothness and durability

of the surface, the absence of fouling, and the preservation of the hull, rendering frequent hauling out unnecessary. This coating should last at least two years without renewal, and if, for any reason, the vessel's hull be damaged, the surface may be easily and quickly repaired by the aid of portable apparatus supplied by the company. Many vessels have already been coppered by this process with very satisfactory results to the owners.

There are many other important uses to which this process may be advantageously applied. Wooden piles exposed to the attacks of the teredos and marine insects may be copper coated and preserved indefinitely, whereas now their destruction is rapid and large sums of money are expended yearly in replacing them. Structures of iron or steel for various purposes may be copper surfaced at little cost and fully protected from corrosion due to dampness or action of sea water.

Excellent facilities for coppering vessels of any tonnage are secured in New York, Boston, and New Orleans, and further detailed information will be furnished on application at the offices of the company, Devonshire Building, Boston, Mass.



LIFE-SAVING BOAT.

A New Life-Saving Device.

Many inventions have been brought out for increasing the safety of life at sea, but the one herewith illustrated has features which recommend it to this class of work. It is claimed that the Carley life float, as it is called, is non-sinkable, non-collapsible, non-capsizable, and is always right side up, no matter how it may be thrown overboard.

The device consists of a continuous copper tube with many air-tight compartments strengthened by flanges or fins. This tube is covered in turn by two inches of compressed cork and wound with canvas, the whole being treated with a special water-proof, non-corrosive paint, in order to be absolutely water-proof. Attached to this cylinder is a rope netting three feet deep, from which is suspended, by rings which travel on lashings, the slatted wooden bottom. The float is constructed in such a manner that, no matter which side of it may fall upon the water, the bottom drops through and is in its proper relation to the buoyant cylinder. Oars and signal flags are lashed to the sides, while a breaker of water and boxes of food can be lashed to the tube. The shipwrecked persons stow themselves inside this elliptical device and are not atop of a wave-swept surface to which they must cling and devote every energy to keep from being washed away. Their haven is an absolutely safe refuge, from which they can eventually be rescued.

Extreme lightness is a feature of the device. Two men can toss the largest size, which weighs 525 pounds and is capable of sustaining forty-five persons, over the bulwarks of a ship. The Carley float alone possesses, in addition to the buoyancy required by law, the capacity of stowing and sustaining weight. A raft capable of sustaining a certain number of pounds in weight, but without the capacity in feet for carrying persons whose aggregate weight is the same amount, is manifestly useless to save the lives of that number of persons. This matter of weight and ability to handle a life raft without davits, cranes, or machinery of any sort is most important, as those who have tried to launch a boat or raft in a seaway have learned. It is stated that there is not another appliance of its kind in the world capable of saving one-half the number of persons that does not weigh fully five times as much as the Carley float.

The inventor, Captain Horace Carley, is an old whaler and merchant sailor. Information can be had by addressing the Carley Life Float Company, Produce Exchange Building, New York. Many of our warships now have these floats as part of their life-saving equipment.

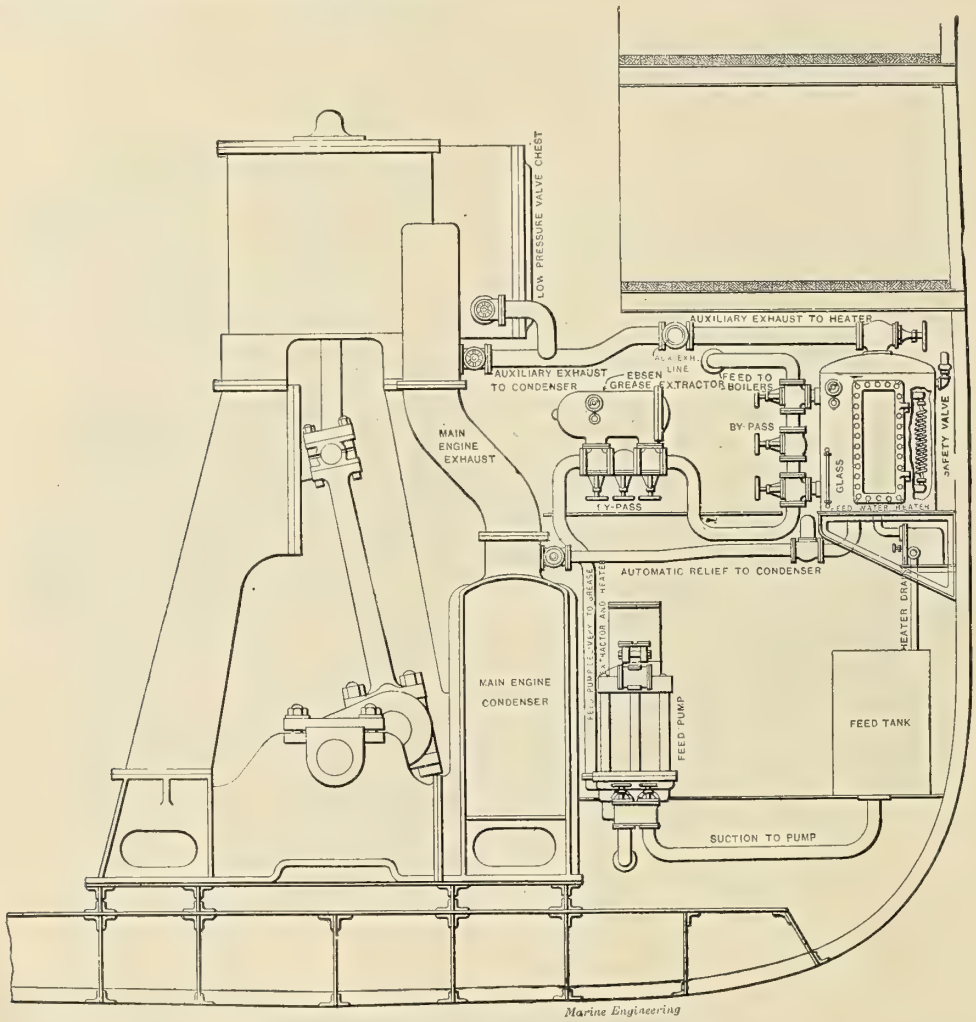
Errata.—On page 10, January, 1903, Marine Engineering, the diameter of the low pressure cylinder of tug *Sea Rover* should be 41 inches and the diameter of propeller 9 feet 6 inches.

The Multicoil Feed Heater.

Herewith is presented a new style of feed-water heater built especially for marine purposes. It has been in use in a number of large and small vessels for many years and has amply demonstrated its efficiency.

It consists of a cylindrical shell made of light steel, bumped heads, fitted with bronze manifolds top and bottom, which are connected by a series of small helical copper coils by means of ground-joint unions of the Quiggin's patent type. The feed water passes through the coils on its way to the boilers, and the auxiliary exhaust is led to the shell and is entirely condensed, the drains being trapped to the feed tank. Owing to the peculiar construction of these coils, the feed water is agitated in passing through them, so that all the heat from the auxiliary exhaust is absorbed by the feed water. All the necessary appliances are fitted to make this apparatus entirely automatic. The coils are perfectly elastic, and no leakage is possible due to expansion and contraction. Furthermore, the apparatus is very light, as there are no heavy castings, bonnets, or tube sheets.

The steam required for the auxiliary system on shipboard is 10 to 18 per cent. of the capacity of the main boilers, 15 per cent. being the average in the transatlantic service. Owing to the poor efficiency of the auxiliary engines, especially the direct-acting pumps, which are great steam consumers, the greater part of the heat escapes into the auxiliary exhaust, and when this exhaust is led to the main condenser this heat is not only lost, but puts additional work on the condenser, circulating pump, and air pump. The advantages of hot feed water need not be discussed here, as the economy derived from it, as well as the saving of wear and tear on boilers, is well known. In former years a feed temperature of 160 to 180 degrees was considered ample, but in latter years the introduction of high pressures on boilers, in conjunction with forced draft, has made the use of hot feed water imperative, and temperatures at boiling point and above are an absolute necessity for easy steaming.



CONNECTIONS FOR MULTICOIL FEED HEATER.

While the absorption or jet heater, which is frequently used on large sea-going vessels, has to a certain extent solved the problem of attaining high feed temperatures, this system, nevertheless, has many disadvantages. It requires the heater to be placed at least 40 to 50 feet above the feed pump and necessitates using two feed pumps. The highest temperature that can be successfully maintained with this heater is 220 degrees under

15 pounds back pressure on the exhaust; and as one of the feed pumps must handle the hot feed water at this temperature, the destructive action of such hot water on this pump is very marked, so that even the best type of Admiralty pattern of pump is short-lived. It cuts the water-end packings, rods, and pump liners, the suction and delivery valves hammer out of shape and break, the valve seats are quickly destroyed, and the pumps race and pound, which they will do periodically even with the best of attention, resulting in fractured water ends in comparatively short time, as well as leaky check valves on the boilers.

As stated before, the jet system entails two expensive feed pumps where ordinarily only one is required, as well as complicated piping and valves. On coasting vessels drawing only 15 to 20 feet of water, the distance of a jet heater above its hot feed pump is less than on deep-draft vessels, owing to the lesser depth of hold, with a result that the feed temperature cannot be maintained much over 200 degrees for that size of vessel, while for all smaller vessels the jet heater cannot be used at all. Furthermore, manœuvering the main engines or slowing or stopping at sea necessitates attention to such a heater, and for that reason, when approaching land, the so-called "change over" is effected by entirely disconnecting the heater and putting the auxiliary exhaust in the main condenser, with a consequent readjustment of the speed of all the auxiliary engines and the feed pumps delivering cold water to the boilers.

As the main engine of modern high pressure ships are run without cylinder lubricants, the auxiliary engines are responsible for the oil which gets into the boilers; and as in a jet heater the auxiliary exhaust is mixed with the feed water, the oil of this exhaust is carried to the boilers. Under such condition the only place where a grease-extracting device can be installed is between the hot feed pump and the boilers; and as high feed temperature dissolves the lubricant, especially the lighter oils contained in it, the extractor is only able to remove a small part of the grease.

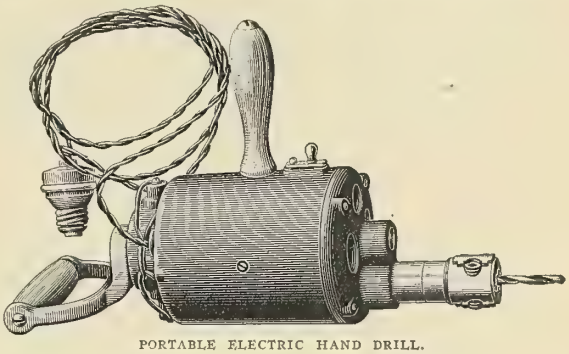
In comparison, the following advantages may be mentioned in favor of the multicoil heater: *It* can be installed on any vessel, from the smallest-size steam launch to a large transatlantic vessel; *it* requires only one feed pump, and that feed pump handles water of only the ordinary hot-well temperature; *it* is absolutely automatic in its action—stopping or manœuvering of the main engines does not affect it in any way.

When sufficient auxiliary exhaust is present the feed temperatures range from 212 to 230 degrees. It can be placed in the lower engine room close to the feed pump and the main auxiliary exhaust line. The back pressure of the auxiliary exhaust line does not exceed 10 pounds, and the feed temperature realized is always equal to the heat of the entering exhaust steam due to its back pressure.

These heaters are made to suit all conditions of marine practice in any size. Particulars may be ascertained by writing James Reilly Repair and Supply Company, 229 West street, New York city.

Electrically-Driven Hand Drill.

A simple portable electrically-driven hand or breast drill has been designed recently by the Hisey-Wolff Machine Company, of Cincinnati. It consists of an enclosed motor suitably geared for driving the drill spindle. The case is provided with two handles, as shown in the engraving, by means of which the tool can be held in any desired position. It may be used in any place where connection can be made with an incandescent lamp socket. It is under perfect control at all times through a switch placed near the vertical handle. The drills are made in



PORTABLE ELECTRIC HAND DRILL.

three sizes, to hold drills from 0 to 1-4 inch, 0 to 3-8 inch, and 0 to 1-2 inch in diameter, at weights of 14, 16, and 24 pounds respectively. Each size is wound for either 110 or 220 volts.

QUERIES AND ANSWERS.

Q. 117.—Will you please advise me through the columns of your magazine the following questions? By doing so you will greatly oblige.

1. The ballast required to sink a floating dock of length 60 feet, beam 40 feet, depth 5 feet 6 inches, wings 10 feet high above floor of dock, 4 feet wide at base, and 3 feet wide at top, so as to float a vessel drawing 4 feet 6 inches of water; height of keel blocks above floor of dock, 4 feet. Draft of dock when light is 3 feet.
2. Will it sink sufficiently to dock vessel without ballast?
3. Is there any rule governing such? M. P. McD.

A.—Since the dock when light, that is, without vessel or ballast of any kind, draws 3 feet, it will be necessary to sink it 11 feet further in order to float in a vessel drawing 4 feet 6 inches over keel blocks 4 feet high. The amount of water ballast required to effect this will exactly equal the additional volume which would be displaced by sinking the dock to this point. That is, it will equal the volume of the dock between the level 3 feet and the level 11 feet higher. It is readily seen that this includes a layer of the main dock 2 feet 6 inches deep and also the wings up to within 16 inches of the top. The volume of the layer of main dock is easily found to be 6,000 cubic feet, while that of each of the wings will be about 1,825 cubic feet, or 3,650 for both. This will give 9,650 cubic feet of additional displacement to sink the dock and this will call for exactly the same amount of water ballast.

If the entire inside of the dock is available for water ballast, then we have only to find how much would be required for this volume of water. The dock being of wood and the dimensions above given being on the outside, the average dimensions of the interior space will not much exceed 59.5 by 39.5. This would give 2,350 square feet of area, and this divided into 9,650 gives 4.1 feet as the depth of water in the dock necessary to sink it to the level required. Actually there is probably

some timbering inside, which would occupy some space, so that the depth is likely to be somewhat greater than the above, or perhaps about 4 feet 3 inches. It appears, however, that there should be no difficulty in sinking the dock with water ballast to the level designated.

The principles upon which such problems are solved will be sufficiently illustrated by the operation detailed above.

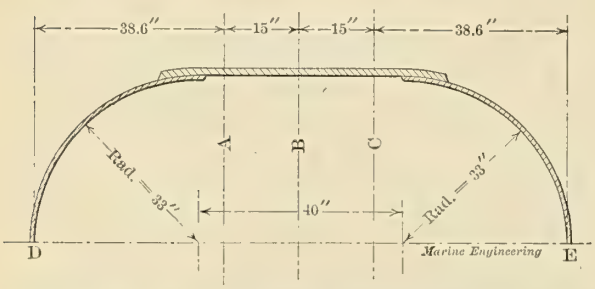
Q. 124.—Can you give me any information concerning the proper size of the propeller to use on a 6 to 8 horse-power engine for driving a light-draft boat? Can the same speed be obtained by using a propeller of 18 inches in diameter of a certain angle as can be obtained by using one of, say, 21 to 23 inches in diameter? The boat draws 18 inches. T. G. K.

A.—It is not possible to give a very definite answer to such a query without more detailed information regarding the dimensions and form of the boat. With the power stated, and with an engine making 350 to 400 revolutions per minute, and at a speed of 8 to 9 miles per hour, a four-bladed propeller about 22 or 23 inches in diameter and with about 30 inches pitch and 160 square inches of blade surface should be employed. The power mentioned cannot be satisfactorily taken care of by an 18-inch wheel with the speed and revolutions likely to be found in the case you mention. In order to obtain the best results with one wheel it will be necessary to use a larger propeller, as noted, and allow it to project below the keel, protected by a skeg, if convenient.

Q. 125.—Will you please give me the blade surface in square feet for a four-bladed propeller to take the place of a three-bladed propeller? The dimensions of the latter are: diameter, 8 feet; pitch, 11 feet; area, 18.3 square feet. We wish the four-bladed propeller to make the same number of revolutions as the three-bladed.

A.—You are advised to put on four blades of about 4.4 square feet area each, or, say, 17.6 square feet in all. This assumes that the diameter and pitch are to remain the same—8 feet and 11 feet respectively. The area—18.3 square feet, as stated—is rather small for a four-bladed propeller and will give rather slender blades; but if the new propeller is to be of the same diameter and pitch as the old, and is to make the same revolutions, the blade area should be about as stated.

Q. 126.—I have a steam drum of the form shown in the sketch. There are two flat sides connected by stays. The distance between the stays in longitudinal view is 19.7 inches. I



calculate the section of the stays B by considering the area supported = 15 x 19.7. As to the stays A and C, I consider the area supported $= \left(\frac{15}{2} + \frac{38.6}{2}\right) \times 19.7$.

Is the calculation for A and C correct? A. V.

A.—The sketch you send shows, of course, one half of the steam drum. The calculation you make for the stays B is correct. For the stays A and C, however, it is not necessary to consider that they support beyond the flat part. Strictly speaking, these stays might be considered as supporting the area $\left(\frac{15}{2} + \frac{5.6}{2}\right) \times 19.7$. It would, however, be as well to add a little to this provision and make the stays A and C of the same size as B. This would correspond to a support carried over toward the farther edge of the joint. The remaining load produced by the steam pressure estimated in a direction at right angles to DE is carried by the tensile stress set up in the material at D and at E.

Q. 127.—Will you please advise me concerning the Schlicht process of combustion and refer me to some plants which are equipped in this way? F. C. Z.

A.—Briefly, the Schlicht process consists of admitting part of the air for the fires down through the chimney, this air being heated by the upgoing gases and supporting combustion of the fire above the grates and in the combustion chamber. Along the axis of the chimney a pipe is inserted, extending a few feet above the top of the chimney and a few feet below the top.

It is found that the upgoing gases will pass on the outside of this pipe, and there will be a down draft of outside air through the pipe. A company was organized a few years ago to introduce this patent system, and several boiler plants were equipped with it, among which might be mentioned the Arbuckle Sugar Refining Works, Brooklyn, N. Y. This system has worked successfully, but it is evident that the capacity of the chimney is cut down, owing to the increased volumes of air, one passing upward and one downward, and the fact that the upgoing gases, because of the heat which they transmit to the down draft, are cold and therefore decrease the draft.

Q. 129.—Please say what method is adopted for ascertaining the horse power of turbine engines, that is, the indicated horse power, and oblige, W. C.

A.—The only way of learning the horse power of a turbine is either by making a brake test or by driving direct-connected an electric generator. These, of course, do not give the indicated horse power, but the developed horse power. The latter method is preferable, for the load can be learned at any time by the use of volt and ammeters.

If V = volts
A = amperes
W = watts
$K.W.$ = kilowatts = 1,000 watts
$E.H.P.$ = electrical horse power
$D.H.P.$ = developed horse power of turbine
e_1 = efficiency of dynamo

$$K.W. = \frac{VA}{1.000}$$

$$E.H.P. = \frac{VA}{775}$$

$$D.H.P. = E.H.P. \div e_1$$

And as

$$K.W. = 1.3\ D.H.P.$$

$$D.H.P. = \frac{VA}{776 e_1}$$

Q. 130.—How do you compute the work done by a pump? L. P. D.

A.—The net work done by a pump, at the point of final delivery, is readily computed if we know the conditions under which it operates and just what its de-

livery is. The net work done in the water cylinder will be greater than this by an amount sufficient to provide for the friction of the water in pipes, resistance of curves, elbows, valves, etc.; while the work developed in the steam cylinder of the pump will be still greater by an amount sufficient to allow for the loss due to friction in the moving parts of the pump and for the slippage or leakage in the water end. Thus, for example, with a feed pump putting water into a boiler, the net work performed as measured at the boiler will be represented by the given amount of water forced in against the pressure in the boiler. If the feed pipe is of good size and the lead from the pump short and straight, the work in the water end of the pump will be only slightly more; while if the pump is small and the lead long and tortuous, there will be required a considerable amount of work simply to force the water through the pipe, the pressure on the pump plunger will be increased accordingly, and with it the work done in this cylinder. Again, if the pump is in good mechanical condition and all parts move freely, the work developed in the steam end will be only slightly more than in the water end, while if the condition is poor and the moving parts operate with great friction much work will be lost in this way, and the work developed in the steam end must be correspondingly increased.

To return to the question of measuring the net delivered work of the pump. This may be done most simply by multiplying the weight in pounds of water handled, by the head against which it is delivered, measured in feet. The product will be the work in foot pounds. The head against which the water is delivered may sometimes be measured directly in feet, as when water is simply hoisted or raised from one level to a higher one. On the other hand, it must often be found from the pressure against which it is delivered, by the following:

Rule: Multiply the pressure in pounds per square inch against which delivery is made by 2.304 and the product will be the head in feet. If, in addition to this, the water is raised also, then the height to which it is raised must be added to give the complete head.

These principles will be illustrated by a few examples, as follows:

(1) Six hundred pounds of water are raised 14 feet. How much work is done? Solution: Work=600×14=8,400 foot pounds.

(2) Ten cubic feet of water are forced into a boiler against a pressure of 160-pound gage. What is the net work? Solution: The weight of water will be 62.5×10=625 pounds. The head will be 160×2.304=368.64. Hence the net work=625×368.64=230,400 foot pounds.

(3) Suppose in example (2) that the boiler is 8 feet above the pump and the pump 6 feet above the tank from which the supply is drawn. Then the total head will be 368.64+14=382.64, and the work will be 382.64×625=239,128.

Next, to find the additional work which must be done to overcome the friction of the water in the pipes and passages, it is found most convenient to express the resistance to be overcome in this way as an addition to the head. The amount of such friction resistance or head can only be determined by a rule or formula based on experience. To this end we may use the following formula:

$$h = \frac{W^2 L}{50{,}000 d^5}$$

where h is head in feet, W is weight in pounds of water delivered per minute, L is length of pipe in feet, and d is diameter of pipe in inches. Thus, for example, what will be the head required to overcome the friction in a pipe 2 inches in diameter and 100 feet long, through which there is a flow of 400 pounds of water per minute?

Solution:

$$h = \frac{400 \times 400 \times 100}{50{,}000 \times 2 \times 2 \times 2 \times 2 \times 2} = 10 \text{ feet.}$$

If this water is forced into a boiler against a pressure of 150 pounds, what will be the net power in the water end of the pump?

Solution:

The pressure head will be 150 × 2.304=345.6 feet.

The friction head will be 10 feet.

To this should be added a further allowance for the special resistance due to bends, passage through valves, etc. This can only be estimated, but we will take it in this case to be 6 feet. Then the total head will be 345.6+10+6=361.6 and the work per minute will be 400×361.6=144,640 foot pounds. To find the horse power we divide by 33,000 and find 144,640÷33,000=4.38.

If this is a feed pump of the ordinary type and in good condition, the mechanical efficiency should be from 75 to 80 per cent., though with poor care it may fall much below this. The power required in the steam end will be, therefore, 4.38÷.75 say, or 5.84 horse power.

Additional examples might be given, and special points might be further discussed, but within the present limits of space the foregoing will serve to show the general line of treatment to be followed in the usual case.

Q. 131.—Kindly let me know what the pressure would be in the shell of an evaporator if the slits in the "dry pipe" became clogged up with salt to such an extent that very little steam or vapor could get to the distiller. The steam gage and safety valve are connected between the dry pipe and the distiller and were both useless when the slits became clogged. We were carrying 40 pounds on the coil and it was kept well drained. The steam or vapor valve to the distiller would have to be almost shut in order to keep 5 pounds on the shell. There was about 3 inches of water in the glass and the connections to same were clear. Would there be a limit to the pressure that would accumulate in the shell under these conditions? F. J. McA.

A.—There would certainly be a limit to the pressure which would accumulate in the evaporator under the circumstances mentioned. The highest possible pressure under any such similar conditions would be 40 pounds, the pressure in the coil, and this would only be possible if there was absolutely no escape for any vapor, and if further the shell of the evaporator was so perfectly covered by lagging and non-conducting material that there would be no loss of heat by radiation or conduction. Under these circumstances the pressure in the shell would gradually rise with the increase in temperature until the water and steam in the shell were both at the same temperature as the steam in the

coil and hence at the same pressure. There would then be no further transfer of heat from the coil to the shell and hence could be no increase of pressure in the latter. Actually this condition could never be realized, for there would always be some small escape of vapor and some loss of heat by radiation and conduction. Your statement that it was necessary to have the vapor valve almost closed in order to keep five pounds on the shell we assume to mean when the dry pipe is open and clear of salt. This shows that with the opening given by the valve "almost shut," the pressure in the shell would rise to only about five pounds. Even with the dry pipe well salted up there would probably be small likelihood of the pressure in the shell rising beyond 10 or 15 pounds with 40 pounds of steam in the coil. This would be an interesting experiment to make, and one easily carried out. Find the highest pressure you can get in the shell with graded openings in the vapor valve from, say, a full turn open down to tight shut, and report your results for the benefit of our readers. We assume that your pressure gage is between the vapor valve on the distiller and the shell, so that it will give you warning in case any undesirable pressure should be reached.

Q. 132.—Please tell me about what lead the high-pressure valve of an engine 4,000 I. H. P. should have, piston speed 800 feet per minute. Would you have the lead the same for a triple or quadruple expansion engine as for single or compound? J. W. C.

A.—This is to some extent a question of taste with the engineer. Some prefer a generous lead, while others prefer to limit it to the smallest amount permissible. For an engine of the size mentioned the lead might be from 3-8 to 1-2 inch, and there seems to be no reason why it should not be about the same whether in a single or multiple expansion engine.

Explosion of the Progresso.—The evidence that has been brought out at the inquiry into the cause of the explosion of the *Progresso* shows that the oil put on board was of too low a flash test. While California law calls for a flash test of but 110 degrees, this oil was found to flash at from 85 to 101 degrees. There was also evidence that a lighter oil had been mixed with a heavy oil to make it flow more readily.

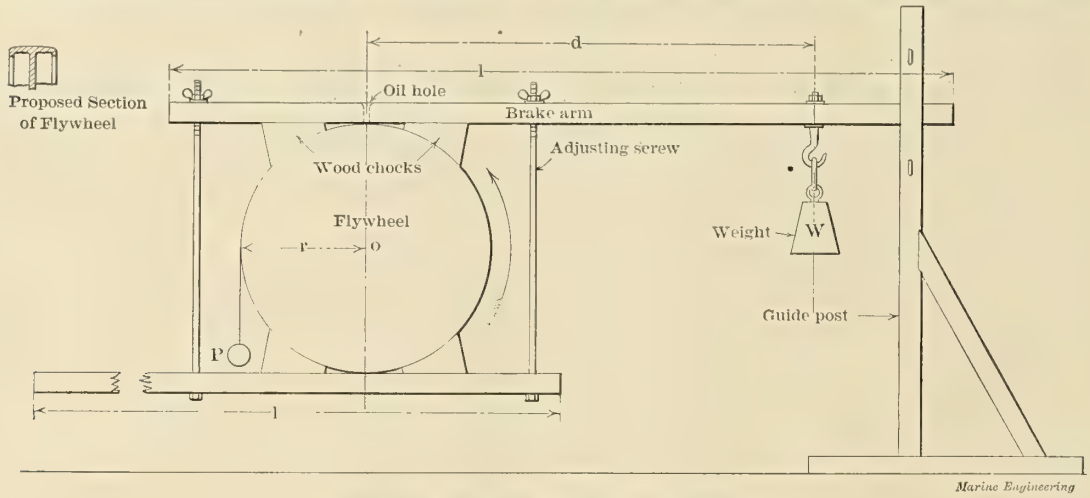
Brake Test of a Gas Engine.

BY ALFRED E. LÜDERS.

The purpose of this article is to give a few hints upon determining the horse power of an engine by what is commonly known as the brake method. Most people know the general idea of the operation; that is to say, they understand that weights are attached to the machine, that the friction is measured and from that the horse power is found. This, of course, is perfectly true, but the few simple little devices utilized to accomplish this end are not so generally known.

To describe the subject properly we will take the test recently applied to a gas engine of a well-known make to ascertain the brake horse power that it developed:

The engine was set up in the machine shop and securely tied to the floor by dogs and bolts in a manner approximating the usual attachment of engine to its foundation in the boat. The exhaust pipe was carried out through the roof, a slight gain in back pressure being realized by the natural tendencies of the hot gases to rise, as against the loss due to forcing the gases out at the stern of the boat through a muffler, and even in some cases exhausting below the water line. Whatever was gained in this manner may have been offset by several right-angle turns in the exhaust pipe, which were naturally a cause of friction. The gasoline was fed to engine by its own pump, forcing gasoline from a small nearby tank through the medium of compressed air, a pressure of about three pounds being obtained in tank by a hand pump to aid the engine in starting. To put a load upon the engine similar to that introduced by the action of the propeller, a brake attachment was rigged up on the flywheel for measuring the power exerted.



FRICTION BRAKE FOR TESTING SMALL ENGINES.

By reference to the figure a good idea of the construction of the brake may be obtained. Two beams are connected by long bolts with butterfly nuts; between them and bearing upon the surface of the flywheel are wooden chucks. The amount of friction applied to the surface is easily adjusted by the butterfly nuts. An oil hole is located over the center of wheel in top arm, as it is necessary to keep the rubbing surfaces running in oil, as the face of the wheel heats very rapidly, caus-

ing the brake to bind and interfere with the steady running of engine.

On the upper or weight arm a hook is attached, and from this hook weights are suspended, as shown in cut.

Now, presuming that the test is in progress, a known weight being attached to hook, it will be seen that if the butterfly nuts are tightened too much the whole brake will revolve (provided weight is not too great for engine to lift) until lower arm brings up against the floor; again, if the screws are too loose, the end of brake will simply rest on the ground, unaffected by the turning of the engine. The object, therefore, is to adjust the tension on the tie bolts so that the engine may revolve freely, and yet to produce enough friction on the brake arms to just keep weight between the two extremes—*i. e.*, revolving completely or dropping to the ground. When everything is working properly the two arms approximate a horizontal position. If now all is running smoothly, the revolutions per minute are noted, as is also the length of weight arm and diameter of flywheel, and we are then in a position to deduce our horse power.

To understand the method properly reference should be made to the diagram. Here the weight arm, in a horizontal position, has a length $= d$ feet from point of contact on the wheel to the point of suspension on the weight. The radius of the flywheel $= 2r$ and the weight would $= W$. According to the fundamental law of dynamics that action and reaction are equal, we must consider that the resistance to the weight W on the brakes is overcome by a force P applied at a distance of r from the center of the shaft. Then, taking the moment of the force about O, we have $Pr = dW$, or $P = \frac{dW}{r}$. This is the condition when the brake arm is unsupported and when the arms of the brake balance each other, thereby eliminating the weight of brake proper as a factor in the calculation.

Now to find the horse power due to the load P. Let us assume the weight P is suspended by a long cord of no weight attached to the end of the flywheel, and that the wheel in revolving will wind the rope on its face.

Power must contain the three elements of time, space, and force. We have already the latter $=$ to P; let us assume the time to be one minute, then the space traveled will be the number of turns of engine in one minute times the circumference of the flywheel, or $N \times 2\pi r$. Then the work done per minute will $= P \times N2\pi r$, or substituting for P, its value above, we have $2NWd$ foot pounds of work per minute. The horse power $= 33{,}000$ foot pounds of work per minute; therefore,

$$H.\ P. = \frac{2\pi NWd}{33{,}000}.$$

To apply this to the case of engine that was tested: The flywheel being 27 inches diameter, the weight arm was 48 inches long, and the weights used, including a 2 1-4-pound hook, were 65 1-4 pounds in one case and 53 pounds in the other. To prevent fore-and-aft play of weight a pair of guide posts were set up (see the figure). The posts were just far enough apart to permit of arm moving up and down freely. A couple of pins limited the vertical movement of arm to about six inches each side of the horizontal.

When everything was in readiness the engine was started, the nuts screwed up until the arm oscillated gently between the two stops, the number of revolutions per minute being taken by an indicator. Three runs were made, of which only the first two should be considered, as during the last trial the heating of the flywheel became so great that the brake was continually binding and bringing the weight arm up against the stops with considerable force, thereby putting excessive and intermittent loads on the engine, materially reducing the revolutions and calculated horse power, it being impossible to make an estimate of the work done by hitting the stops.

The motor was rated at twenty-five horse power, and appended is a list of the trials and their results:

Run No.	Weight.	Rev. per Min.	Brake H. P.
1	65¼	500	24.8
2	65¼	540	26.8
3	53	600	24.2
Average....	61.16	546	25.3

[While the method above described will answer the purpose, it is advisable to increase the surface of the wood chucks against the face of the flywheel and steady them from slipping off the flywheel by small blocks nailed to either side of the chucks. Unless some special form of lubricating is used the heating effect due to friction is a serious obstacle in making a reliable test. It is advisable to have a stream of water playing on the face of the pulley, or, where there is an inside ridge on either edge of the pulley, fill this space with water when the engine is running. This will keep the temperature down. Where possible a pair of scales should be used in place of the weight, and a much heavier weight than is necessary placed on the scales and tied to the horizontal brake arm, care being taken to have the cord used in a vertical line; then the zero reading of the scales may be taken with the engine at rest, and whatever load is applied by tightening the butterfly nuts can be read on the arm of the scale by keeping the scales in constant balance.—EDITOR.]

Submarine Torpedo-Boat Destroyers.—It is stated that the British Admiralty is preparing plans for a new type of boat for meeting the attacks of and destroying a submarine torpedo boat.

Twelve Months' Shipbuilding Returns.—The Bureau of Navigation reports 1,262 sail and steam vessels of 429,327 gross tons built in the United States and officially numbered during the year ended December 31, 1902, as follows: On the Atlantic and Gulf coasts, 856 vessels of 214,538 gross tons; in Porto Rico, 9 vessels of 137 gross tons; on the Pacific coast, 161 of 48,432 gross tons; in Hawaii, 4 of 35 gross tons; on the Great Lakes, 104 of 158,230 gross tons; on the Western rivers, 128 vessels of 7,955 gross tons. Wooden vessels numbering 1,137, of 121,269 gross tons, were built in these districts; the only steel sailing vessels were built for the Atlantic and Gulf, and were 9 in number, of 13,345 gross tons; no steel vessels were built in Porto Rico or Hawaii. During the corresponding year, under date of December 31, 1901, 1,322 sail and steam vessels of 376,129 gross tons were built in the United States and officially numbered.

TECHNICAL PUBLICATIONS.

The Slide Valve and Its Functions. By Julius Begtrup. Size 6 by 9 inches, pp. 143, with 87 figures. Price, $2.00. D. Van Nostrand and Co., New York.

The purpose of the author in the preparation of this work has been to treat the general subject of the slide valve, with due regard to the various requirements of modern practice. The fundamental geometry of the slide valve is discussed and its movements are analyzed by the Sweet form of valve diagram—a form which is less well known than the Zeuner or Belgram diagram, but which the author considers preferable and which he has, therefore, used throughout the work. By the aid of the few fundamental principles as embodied in this diagram a number of special valve constructions are described and analyzed, thus illustrating the varied way in which the exacting conditions of modern practice have been met by modern builders. While the title of the book refers to the "slide" valve, the rotating valves of the Corliss type and others used on "four valve" systems are included in the treatment as well. Extended reference is also made to the various types of independent cut-off gears, both of the older and more modern forms. The slide valve as applied to pumps has not always attracted from writers on this subject the attention which the problems involved have merited. In this book, however, a chapter on the subject is included, and the valve motions found on the leading types of pumps are illustrated and discussed with reference to the problems of steam distribution presented by this class of machinery. The book closes with a chapter on the angularity of the connecting rod and of the eccentric rod, and their influence on the steam distribution with reference to the motion of the piston. A discussion is also given of the use of the rocker arm for equalizing the lead and cut-off, and of various refinements which may occasionally be introduced into the solution of problems of steam distribution.

The marine engineer will miss any adequate treatment of the Stephenson link and other types of marine valve gears. The Stephenson link of the locomotive type and fitted for the reversing rocker arm is briefly referred to, but the student of marine valve gears would hardly find this treatment sufficient for the discussion of the special problems with which he is usually concerned.

In general, however, and within the scope intended by the author, the treatment is clear and adequate for the purposes in view. The style of the author is suggestive rather than exhaustive, and he explicitly states that it is his express purpose to stimulate study and thought on the part of the reader, in order that in his own way he may make the subject his own. The illustrative figures are excellent, as also the presswork and binding, and the book, as a whole, is one which will undoubtedly serve well in its field of special use.

Record of American and Foreign Shipping. 1,300 pages, 8 by 9 1-2 inches. Price $5.00. Published by the American Bureau of Shipping, 66 Beaver street, New York.

The volume for 1903 of the "Record of American and Foreign Shipping," which is the thirty-fifth annual issue of this valuable register, is now being delivered to subscribers. The "Record" contains full reports and particulars of about 17,000 vessels, ranging from the infrequent ketch to the full-powered transatlantic liner and flying the flag of every nation, alphabetically arranged; with much detail as to build, ownership, and condition. This information forms the bulk of the annual volume, but it also contains rules for the construction and classification of all classes of vessels, with illustrations and tables, all of utmost technical and practical value; rules for the construction of machinery and boilers, and suggestions and recommendations for the installation of electrical apparatus on shipboard. The volume contains names of vessels which have been changed; list of compound names arranged alphabetically by last word of name, for ready reference; list of addresses of prominent shipbuilders, dry-docks, and marine railways of the United States; list of owners of vessels, all of much value to the shipping interests.

The work is approved and indorsed by the important boards of underwriters of the United States and is accepted by the merchants and underwriters throughout the world as a standard classification of shipping. Supplements to the volume, issued semi-monthly, keep subscribers informed of new vessels constructed during this year, with reports of repairs to old vessels and other useful information.

The "Practical Engineer" Electrical Pocket Book and Diary for 1903. Size 5 1-2 by 3 1-2 inches, pp. 339, with 64 pages for diary. Gilt edges, flexible morocco, with rubber band and pocket inside of cover. Price 1 shilling 6 pence. Technical Publishing Company, Manchester, England.

This is the fourth annual edition of a pocket book which is intended to be an every-day guide to the electrical engineer, and at a moderate price to furnish him with such formulæ, constants, data tables, and general information as he may need in the daily practice of his profession.

The present edition contains many improvements over previous issues, among which mention may be made of articles on the various conduit systems of wiring, on the comparative expense of operating hydraulic and electric elevators, recent legislation relating to electric installations, etc. The purpose of the editor in the preparation of this book seems to have been well attained, and it may be cordially recommended as a convenient and useful pocket companion for those who are engaged in work relating to applied electricity and electrical engineering in its various branches.

The "Practical Engineer" Pocket Book and Diary for 1903. Size 5 1-2 by 3 1-2 inches, pp. 568, with 64 pages for diary. Gilt edges, flexible morocco, with rubber band and pocket on inside of cover. Price 1 shilling 6 pence. Technical Publishing Company, Manchester, England.

This edition of the engineer's pocket book is the fifteenth published under the same auspices, and represents, therefore, the results of a long series of years in the preparation of engineering literature of this character. The book contains a good selection of engineering tables, formulæ, data, memoranda, and miscellaneous information which the engineer is liable to need at any and all times. The present edition, among other additions, contains tables of equivalents of feet and inches with millimeters, between 1-32 inch and 2 feet by increments of 1-32 inch, and between 1 inch and 20 feet by increments of 1 inch.

The subject matter seems to have been well selected, and the book should prove a most acceptable pocket companion for the engineer in the practice of his profession.

SELECTED MARINE PATENTS.

715,261. LIFE PRESERVER. JOSEPH B. HAMILTON, SPRINGFIELD, MASS.

Claim.—1. A life preserver composed of an annular casing of textile or other flexible material, and having enclosed therewithin segments of cork or like buoyant material, said casing being provided with an inwardly-extending annular flexible lip provided with a tube *f* and having enclosed therein a ring of flexible material substantially as described. Two claims.

715,325. PILOT-HOUSE INDICATOR FOR STEAMBOATS, ETC. JOHN N. WAINMAN, EVANSVILLE, IND.

Claim.—1. In a device of the class described, the combination with a movable indicator adapted to travel in opposite directions from a neutral point and a spring adapted for retracting said indicator or moving it in one direction, of an alarm sounded by the movement of said indicator when it passes its neutral position, and an operative connection between said indicator and the engine-controlling lever, whereby the movements of the lever are duplicated by the indicator and the alarm sounded on the movement of the indicator from its neutral position. Three claims.

715,395. PROPELLER-CONTROLLING DEVICE FOR SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN. Five claims.

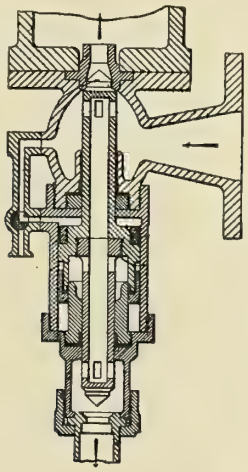
715,882. BOW-FACING ROWING MECHANISM. DANIEL R. SHEEN, PEORIA, ILL. Ten claims.

715,938. LIFE PRESERVER. JOHN E. ARMSTRONG, SANTA CRUZ, CAL.

Claim.—1. A life preserver or buoy including a narrow breast float and a segmental float to be positioned back of the head, and means for adjustably attaching the floats, said floats capable of automatically positioning the body face upwardly while in the water. Seven claims.

715,939. LOG RAFT. JOHN AYRES, PORTLAND, ORE., ASSIGNOR TO OREGON RAFTING COMPANY, PORTLAND, ORE. Six claims.

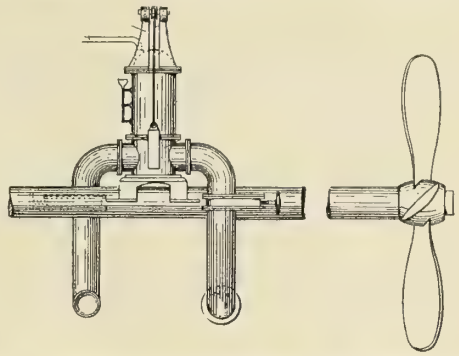
716,418. ASH EJECTOR. LUDWIG HOCHSTEIN, DIETRICHSDORF, GERMANY.



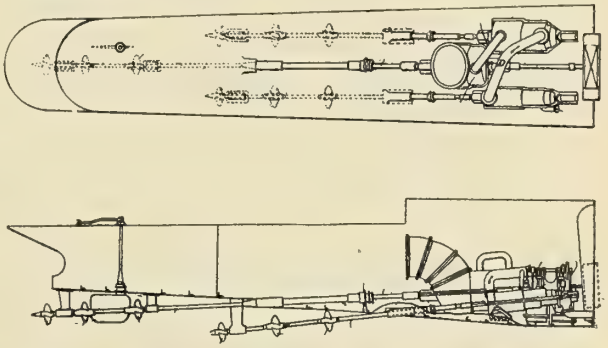
Claim.—1. An apparatus for permitting the pumps of ash ejectors to be kept in continuous action comprising in combination: two valve seats; a valve cone adapted to close each valve seat; a tube connecting said valve cones and having openings near each valve cone; a piston body mounted on said tube; a chamber enclosing said piston body; a chamber enclosing each end of said tube; a pressure main connected with one of the chambers surrounding the ends of said tube; channels connecting one surface of said piston with the chamber connected with said pressure main and with the atmosphere; and a cock adapted to open and close said channels according to desire; substantially as set forth. Four claims.

716,123. MEANS FOR PREVENTING RACING IN SCREW-PROPELLED VESSELS. GEORGE SOLLITT, HASTINGS, NEW ZEALAND.

2. In appliances for preventing racing in screw-propelled vessels in combination, an air-tight cylinder fitted vertically within the vessel, a chamber beneath the cylinder communicating therewith, pipes leading from the chamber through the hull of the vessel, a piston within the cylinder provided with a piston rod projecting through the top end of the cylinder, counterweights attached to the piston rod, an auxiliary air-tight cylinder provided with a piston and piston rod connected to gearing adapted to open and close the valve of the steam pipe leading to the engines, and a pipe connection leading from the top end of the main cylinder to the bottom end of the auxiliary cylinder, as herein specified. Two claims.



716,468. PROPELLING VESSELS BY STEAM TURBINES. CHAS. A. PARSONS, NEWCASTLE-UPON-TYNE, ENGLAND.



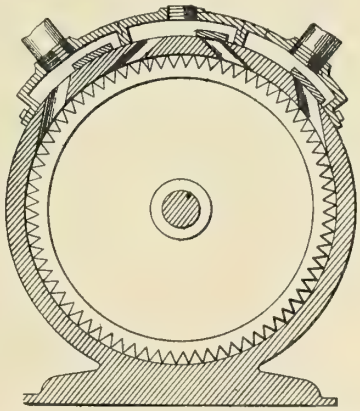
Claim.—In combination with the vessel, a plurality of steam turbines, a propeller connected to each turbine whereby the required blade area is obtained and a steam supply, the said turbines being connected thereto in series whereby the steam passes through the turbines in series and the whole expansive force is utilized and distributed to the several propellers, substantially as described. Two claims.

716,617. MARINE SIGNALING APPARATUS. WILLIAM B. BARKER, LIVERPOOL, ENGLAND. One claim.

716,678. METHOD OF COATING SHIPS' BOTTOMS OR OTHER OBJECTS. ALONZO P. CUTHRIELL, PORTSMOUTH, VA., ASSIGNOR OF TWO-THIRDS TO CHARLES A. McLEAN AND HARRY L. MAYNARD, PORTSMOUTH, VA.

Claim.—1. A method of coating ships' bottoms and other objects, consisting of applying anti-corrosive composition thereto consisting of ferric oxid, oxid of zinc, shellac varnish, linseed oil, turpentine, and oil of pine tar, drying the said coating, and then applying a coating of an anti-fouling composition. Three claims.

716,791. ROTARY MOTOR. DELEVAN P. UPSON, JACKSONVILLE, FLA.



Claim.—A rotary impact motor comprising a cylinder or casing, a shaft extending therethrough, a piston having a widened peripheral portion, and having in its periphery a plurality of transversely-extended recesses forming piston blades, an inlet port leading through the cylinder or casing, said inlet port having a cross-sectional area equal to that of the piston blade against which the actuating fluid impinges and the port being disposed on a line tangential to the piston and in a plane at a right angle to the plane of the piston blades when opposite said

port, and an exhaust port also formed in the cylinder or casing and extending on lines similar to those of the fluid-inlet port. One claim.

716,908. ELASTIC-FLUID TURBINE. TORE G. E. LINDMARK, STOCKHOLM, SWEDEN. Nineteen claims.

716,936. STEAM TURBINE. JOHN RICHARDS, SAN FRANCISCO, CAL.

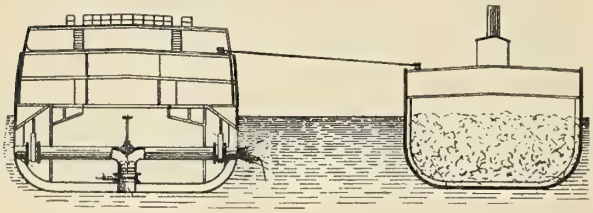
717,059. TURBINE ENGINE. SAMUEL J. WEBB, MINDEN, LA. Six claims.

717,101. SUBMARINE BOAT. SIMON LAKE, BRIDGEPORT, CONN. Twelve claims.

717,196. MEANS FOR CONVEYING OIL FOR CALMING WAVES. CHARLES LA FLETCHER HILLMAN, SANTIAGO, CHILE.

Claim.—4. An apparatus provided with a tube having discharge apertures, and tube provided with another non-perforated tube arranged parallel thereto and adapted to supply the material employed, that with apertures being extended to or near a deposit or point whence the tube without apertures receives its material. Eighteen claims.

717,356. MEANS FOR COALING SHIPS AT SEA. ANDREW C. CUNNINGHAM, WASHINGTON, D. C.



Claim.—2. The combination of a ship to be coaled, a collier or supply ship, a flexible connection athwartships between said ships of sufficient length to permit both ships to roll and pitch without interference with each other, and means for creating a lateral pressure between each of said ships and the surrounding water on the side toward the other ship sufficient to maintain them at such distance apart. Two claims.

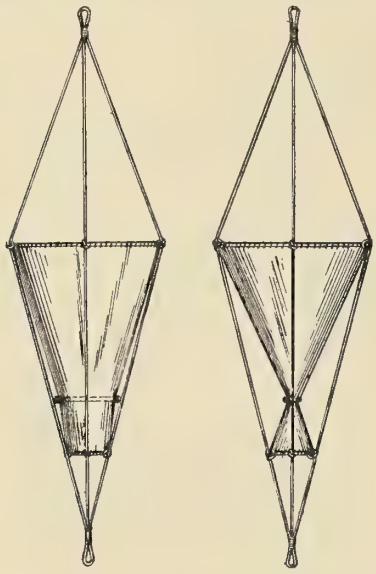
717,563. APPARATUS FOR HANDLING AUTOMOBILE TORPEDOES. BRADLEY A. FISKE, U. S. NAVY. Four claims.

717,590. SHIP'S RUDDER. OSWALD S. MEARS, BLOOMTOWN, VA., ASSIGNOR OF ONE-HALF TO H. C. DARBEE, SEAFORD, DEL.

Claim.—1. The combination with the ship having a chamber adjacent to its stern post, said chamber having side openings adjacent to the said stern post, of a movable rudder and post to which it is connected, and means for moving said post and rudder.

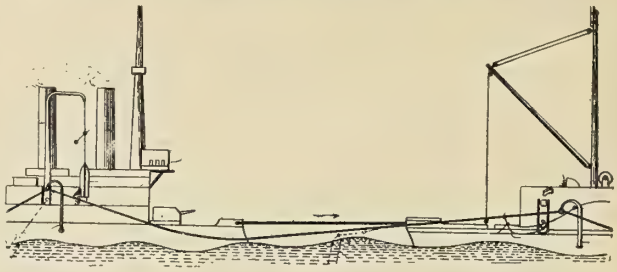
2. The combination with a ship having a chamber adjacent to its stern post, of a supplemental rudder located in said chamber and adapted to move rearwardly to bring the same in operation, and means for moving the said rudder, as described. Four claims.

717,890. SEA ANCHOR. THOMAS S. MILLER, SOUTH ORANGE, N. J. FILED JAN. 24, 1901. SERIAL NO. 44,498. (NO MODEL.)



Claim.—2. A sea anchor consisting of a hollow structure adapted to permit passage of the water therethrough and having a relatively contracted discharge opening of variable area, and means for attaching a cable to the end of the anchor. Fourteen claims.

717,682. DEVICE FOR LOADING VESSELS. FRANK HONECK AND ROBERT H. HOPKINS, SEATTLE, WASH.



Claim.—2. A pull boat, a pulled boat, a tow line, a guide cable extending from one boat to the other and disposed in proximity to the water line, a buoyant receptacle adapted to be moved through the water and having means for connecting the same movable on said guide cable, substantially as described. Eighteen claims.

718,006. SOUNDING APPARATUS. JOHN F. LEWIS, PHILADELPHIA, PA. Three claims.

718,156. PROPELLING MECHANISM FOR BOATS. DOURA C. PUTNAM, LYONS, N. Y.

Claim.—1. A propelling mechanism for boats comprising a support, intermeshing gears journaled on the support and provided with angular brackets disposed at the same side of their respective axes when the brackets are in their operative position, and oar sections having their adjacent ends secured to said brackets. Six claims.

718,162. PROPELLING MECHANISM FOR BOATS. DANIEL R. SHEEN, PEORIA, ILL. Fifteen claims.

718,368. MARINE CONVEYER. THOMAS S. MILLER, SOUTH ORANGE, N. J.

Claim.—1. In a marine conveyer the combination with a cableway having a transit rope extending between two vessels, a carriage actuated by said transit rope, and means exterior to both of said vessels for actuating said transit rope to convey the load carriage from one vessel to the other. Eleven claims.

Monitor Nevada.—The last of the four single-turreted monitors, the *Nevada,* recently underwent her official trial over the Cape Ann course. The ship made, according to official report, 12.8 knots speed for one hour. The vessel was contracted by the Bath Iron Works for $960,000.

Captain A. F. Lucas.—The oil-tank steamer *Captain A. F. Lucas,* under construction at Wm. R. Trigg Company's yard, Richmond, Va., was built from the designs of Mr. D. E. Ford, Philadelphia, consulting engineer for the Standard Oil Company. The steering engine will be supplied by Williamson Bros. Company, Philadelphia, Pa., instead of as stated in the description which appeared in the December number of Marine Engineering.

Oil Fuel.—A very serious setback in the oil-fuel trade has been occasioned by the advance in the price of crude oil and the diminishing of the output of the Beaumont wells. Last summer many of the gushers ceased to gush and since then many of the wells have given decreased quantities of oil. Reports from several shipyards state that no new contracts for equipping tank steamers are being given out, and that wherever possible old contracts have been canceled. The output from other oil fields, however, is not checked.

Iron Ore Shipments.—The iron ore shipped on the Lakes from American ports during 1902 amounts to 27,039,169 tons. This does not include 298,420 tons shipped from the Clerque mines in Canada nor the shipments by rail to furnaces near the mines, which are estimated at about 450,000 tons. Thus the grand total will be close to 28,000,000 tons, which is more than was mined or produced in the thirty-one years between 1855 and 1885 inclusive. It is nearly three times the output of 1896, and represents an increase of about 35 per cent. of last year.